

CHAPTER 2

SURFACE OBSERVATION EQUIPMENT

INTRODUCTION

As a surface aviation weather observer, you must have a thorough knowledge of the equipment used in the observation process. This chapter will guide you through the various types of equipment used to conduct a surface aviation weather observation, both ashore and aboard ship. Both primary and backup systems are covered.

AUTOMATIC WEATHER STATIONS

LEARNING OBJECTIVE: Describe the major components and characteristics of the Automated Surface Observing System (ASOS), the Shipboard Meteorological and Oceanographic Observing System (SMOOS), and the meteorological buoy.

Automatic weather stations are electronic packages that sample, record, and display or transmit weather information to a collection site or user. In the mid-1970's, several systems were introduced that could measure temperature, wind, pressure, and precipitation. By the early 1980's, sensors were developed that could determine sky cover and visibility. In the mid-1980's remote observation sites were in use, providing full spectrum observation data via satellite and phone lines. In 1988, installation was started on a network of Automatic Meteorological Observation Stations (AMOS) in the Pacific to support the Joint Typhoon Warning Center. In the late 1990's, we will see more of these automatic weather stations installed.

The automated weather stations in use by the Navy and Marine Corps at shore stations are called Automated Surface Observing Systems (ASOS), while the equipment system used for shipboard observations is called the Shipboard Meteorological and Oceanographic Observing System (SMOOS). The widely used meteorological buoys are also a type of fully automated weather stations.

AUTOMATED SURFACE OBSERVING SYSTEM (ASOS)

The Automated Surface Observing System (ASOS) is a configuration of fully automated observation

equipment that will replace observation equipment at all shore stations. These automated systems are currently being installed. The AN/GMQ-29 semiautomatic weather station, the AN/GMQ-32 transmissometer system, the AN/GMQ-13 cloud height set, and the AN/UMQ-5 wind-measuring set will be replaced. The ASOS automatically collects, processes, and error checks observation data and formats. In addition, ASOS automatically displays, archives, and reports weather elements included in a surface weather observation.

Display and Control Terminal

The ASOS equipment consists of several components that look very much like a standard desktop computer. The heart of an ASOS is the acquisition control unit (ACU). The ACU receives data by radio link from up to three data collection packages (DCPs). The DCPs are located near the sensors at the touchdown end of a runway and get raw data from individual sensors via a fiber-optic link.

Inside the meteorological office, a computer keyboard and video monitor serve as an interactive user terminal that allows the observer to both receive data and send commands to the ACU. A computer-style printer prints out selected data and observations. The system is also equipped with an audio alarm and a microphone that is used to record supplements to the voice-produced telephone weather report. Telephone and radio modems are used to link the system with various users, maintenance personnel, and on-line weather reporting circuits. A liquid crystal display (LCD) display maybe located in the control tower to keep the air traffic controllers informed of the latest weather conditions. Software menus guide the user through entry of supplemental observation data, file maintenance, and other procedures.

The ASOS provides several types of data for various requirements. The product outputs are as follows:

- Complete weather observations updated each minute
- Wind speed and direction updated every 5 seconds

- Altimeter settings updated each minute
- An Hourly Surface Aviation Weather Observation report
- Daily weather summary to monitor or printer
- Monthly weather summary to monitor or printer

Sensor Package

One or more ASOS sensor packages (fig. 2-1) are normally located at the touch-down end of main runways. From left to right, figure 2-1 shows the following sensors:

- Visibility sensor-Reports equivalent visibility in 1/4-statute-mile increments up to 10 statute miles
- Present weather sensor-Uses an infrared beam to sense precipitation, and reports light, moderate, and heavy rain, snow, or mixed precipitation

- Wind direction and wind speed-Measures speed, in knots, from 0 to 125 knots
- Data collection package (equipment case)-Sends semiprocessed data to the acquisition control unit in the weather office
- Temperature and dew-point sensor-Measures temperature from -80°F to 130°F and dew-point from -30°F to 86°F to the nearest tenth of a degree, and also computes relative humidity
- Heated tipping-bucket rain gauge-Measures precipitation rate from 0 to 10.0 inches per hour, in hundredths of an inch
- Cloud height sensor-A laser detector that reports cloud bases from 100 feet above ground level (AGL) to 12,000 feet AGL

A digital pressure transducer that measures atmospheric pressure from 16.90 inches to 31.50



Figure 2-1.—ASOS sensors: A. Visibility sensor; B. present weather sensor; C. wind direction and wind speed sensor; D. freezing rain sensor; E. DCP antenna and data collection package (equipment case); F. temperature and dew-point sensors; G. rain gauge; and H. cloud height sensor.

inches, a freezing precipitation detector, and a day/night illumination sensor are not shown in figure 2-1. The ASOS will provide station pressure, sea level pressure, pressure altitude (PA), and density altitude (DA) values. Also, additional sensors may be added to the package at a later time.

Operation and Maintenance

Detailed instructions on the operation and maintenance of the sensor package are provided with the manufacturer's User's Manual supplied with each installation.

SHIPBOARD METEOROLOGICAL AND OCEANOGRAPHIC OBSERVING SYSTEM (SMOOS)

The Shipboard Meteorological and Oceanographic Observing System (SMOOS) is an add-on system of supplemental shipboard sensors for the Tactical Environmental Support System (TESS). The "Observer" function in TESS provides the ability to enter local environmental observation data, construct observation report messages, review received messages, and correct erroneous data.

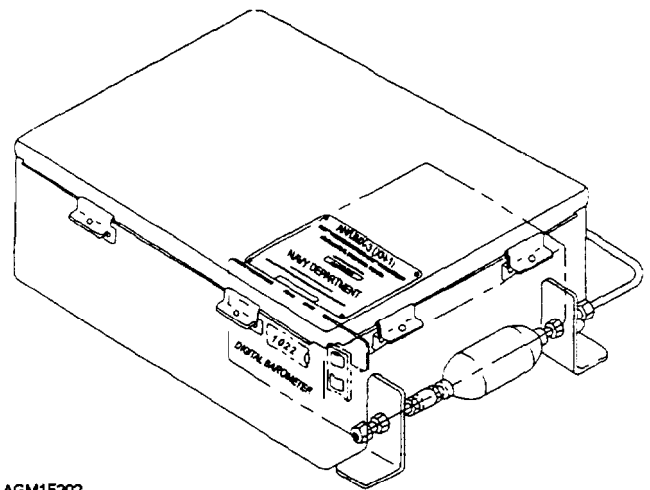
The SMOOS is a suite of environmental sensors that provide continuous automated measurement of meteorological and oceanographic parameters. The sensors automatically send the data to TESS, where it is processed, error-checked, displayed, and distributed. The observer may supplement or override data from the automatic sensors. SMOOS will input data from shipboard wind speed and direction transmitters and from the following sensors:

- Atmospheric pressure sensor
- Temperature/dew-point sensor
- Cloud height detector
- Visibility sensor
- Precipitation sensor
- Seawater temperature sensor

Operation and maintenance manuals are provided with each installation. Now let's briefly discuss the sensors.

Atmospheric Pressure Sensor

The atmospheric pressure sensor assembly is shown in figure 2-2. It is a digital barometer mounted in a weatherproof case with shock protection. It has an accuracy of 11.0 hectopascal (hPa) within a range of 860 to 1,060 hPa.

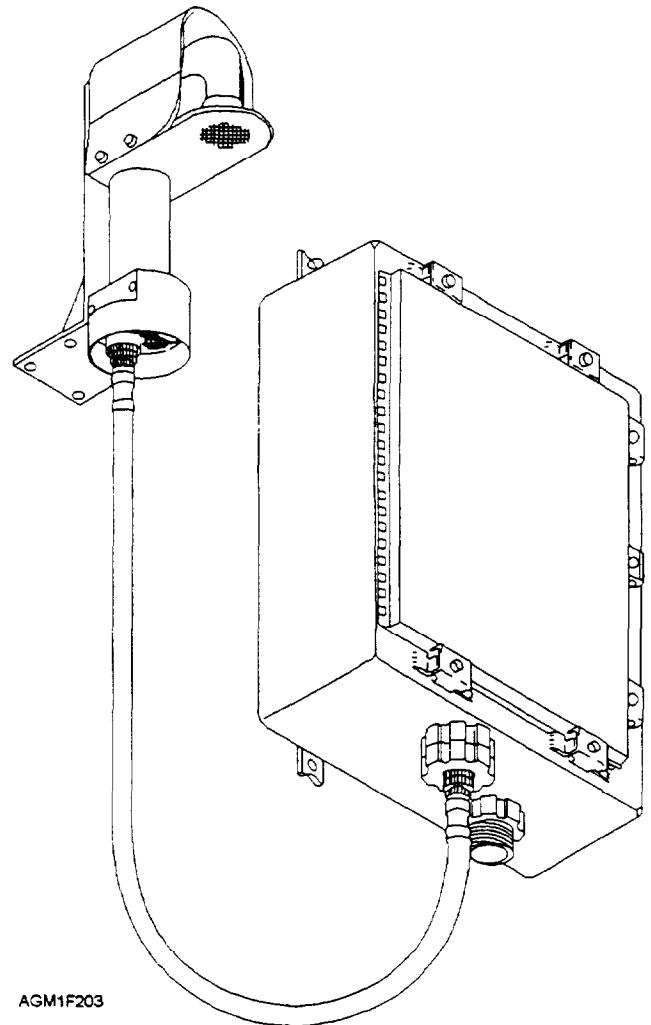


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Figure 2-2.—SMOOS atmospheric pressure sensor.

Temperature and Dew-Point Sensor

Figure 2-3 shows the combined temperature/dew-point sensor. The dew-point sensor is a fan-ventilated



AGM1F203

Figure 2-3.—SMOOS temperature/dew-point sensor.

electronic sensor that measures the moisture content of the air. Mounted on the exterior of a ship, the sensor is protected from heat and solar radiation. The temperature measurements are accurate to within $\pm 1.0^{\circ}\text{F}$ over the range -40°F to 130°F , while the dew-point temperature is accurate to within $\pm 2.0^{\circ}\text{F}$ over the range -40°F to 100°F .

Cloud-Height Detector

The cloud-height detector is shown in figure 2-4. It is a laser ceilometer that automatically detects cloud layers and provides measurements for up to three cloud-base levels. When the visibility is greater than 3 miles, the detector can measure up to 12,000 feet. It can only measure up to 3,000 feet when the visibility is 1 1/2 to 3 miles or during moderate to heavy rain.

Visibility Sensor

The visibility sensor is shown in figure 2-5. It determines equivalent visibility by measuring forward

scattering of an infrared beam by aerosols. The sensor reports equivalent visibility over the range of zero to 10 nautical miles.

Precipitation Sensor

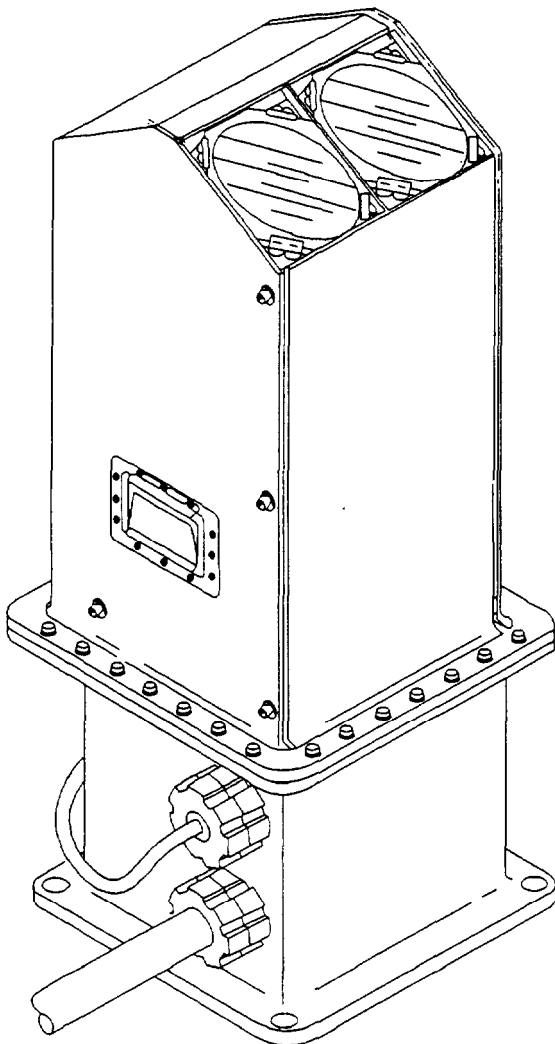
The precipitation sensor (fig. 2-5) uses an infrared beam to detect the droplet size and number of droplets falling through the sensor beam. The sensor reports precipitation rates between 0 and 50 millimeters (mm) per hour and the onset or cessation of precipitation.

Seawater Temperature Sensor

The seawater temperature sensor is usually located near the ship's seawater intake valves, below the water line. It measures the seawater temperature in degrees Fahrenheit and has a range of 25.0°F to 122.0°F . Due to the sensor being located well below the sea surface, hand-held sea surface temperature measuring instruments may be used in lieu of the SMOOS sensor.

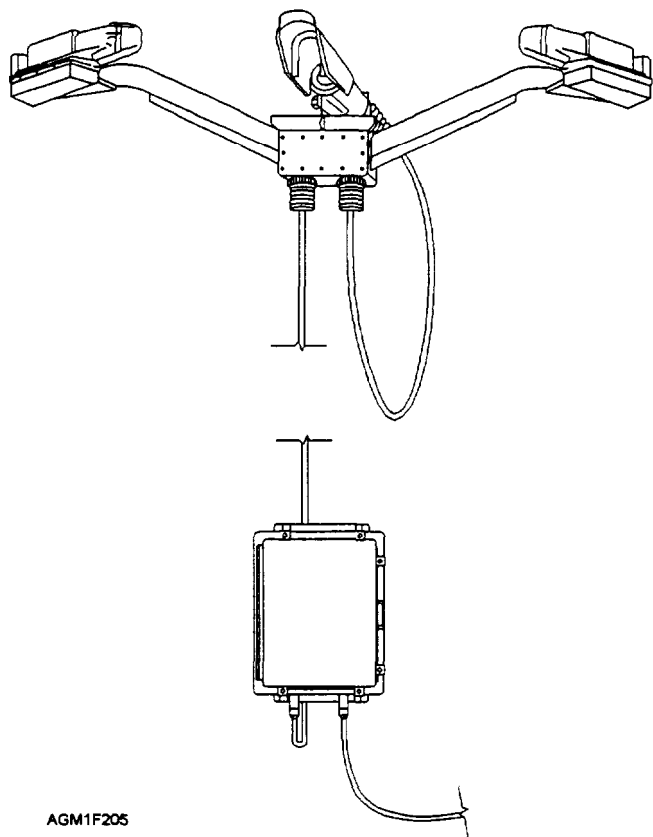
METEOROLOGICAL BUOYS

A third type of automatic weather station is the meteorological buoy. Meteorological buoys may be



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Figure 2-4.—SMOOS cloud-height detector.



AGM1F205

Figure 2-5.—SMOOS visibility sensor (on left and right arms) and SMOOS precipitation sensor (in center).

either moored in a permanent location or drifting buoys. Routinely deployed by aircraft since 1989, drifting meteorological buoys (fig. 2-6) are sonobuoy-size weather stations that provide wind, air pressure, air and sea surface temperature, wave period, and sea temperature/salinity depth profiles to collection points via satellite.

As an observer, you will have little opportunity to see a fully automatic weather station, since no observer support is required. However, you will use observations and data transmitted by these stations. We discuss these products in later modules.

REVIEW QUESTIONS

- Q1. How often are ASOS observations updated?
- Q2. How does the ASOS system detect precipitation?
- Q3. What system does SMOOS interface with?
- Q4. The SMOOS can detect clouds at what maximum height?
- Q5. How do drifting and moored oceanographic buoys relay information to collection sites?

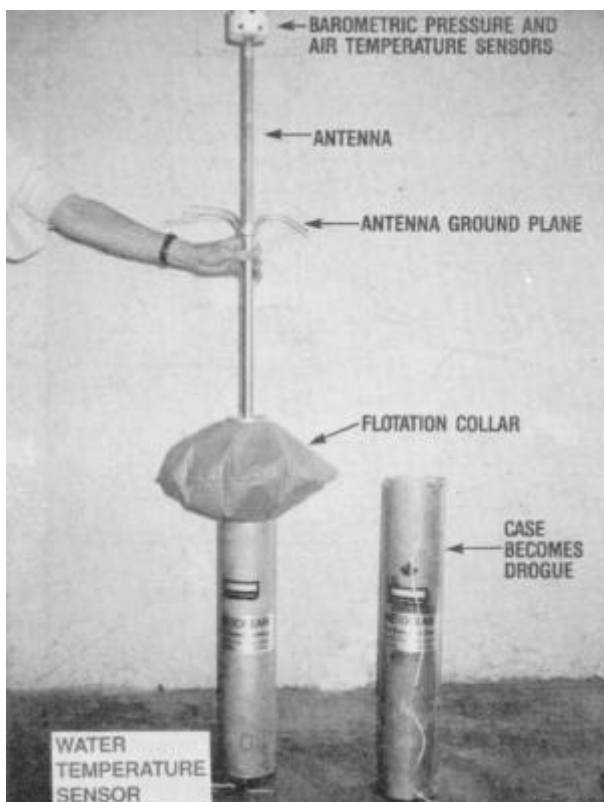


Figure 2-6.—Drifting buoy.

SEMI-AUTOMATIC WEATHER STATION

LEARNING OBJECTIVE: Identify the major components and characteristics of the AN/GMQ-29 semiautomatic weather station.

At some observing stations, the primary-use weather observation equipment is still the AN/GMQ-29 automatic weather station. Although called the *Automatic Weather Station* when first introduced, this equipment earned the more popular term *semiautomatic weather station* after truly automatic weather observations were introduced. First operated in 1975, the AN/GMQ-29 uses electronic and electromechanical sensors to measure temperature, pressure, precipitation, and winds. This equipment was installed at all Naval Meteorology and Oceanography detachments, facilities, and centers. The manual that describes operating procedures for this equipment is NAVAIR 50-30 GMQ-29-2, *Handbook of Operation, Service and Overhaul Instructions with Illustrated Parts Breakdown for the Automatic Weather Station (AN/GMQ-29A)*. There are two major groups of equipment in the system: the display group and the sensor group. Figure 2-7 shows the display group,

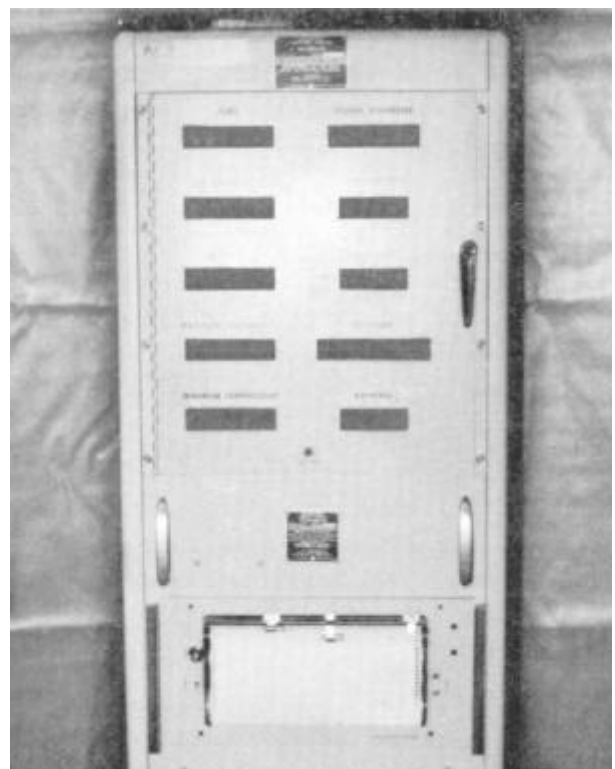


Figure 2-7.—AN/GMQ-29 display group.

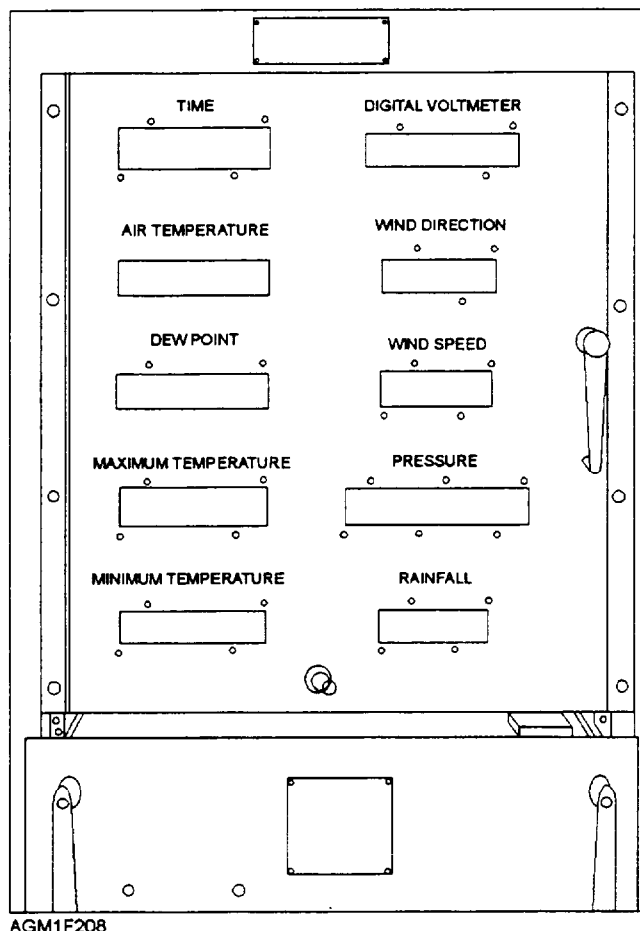


Figure 2-8.—AN/GMQ-29 readout panel.

located in the weather office. The sensor group is usually located near the runway. First, let's look at the display group.

DISPLAY GROUP

The display group consists of a light emitting diode (LED) readout panel, a slide-mount drawer that contains the controller and processing electronics and switches, and the RO-447/GMQ-29 analog recorder for wind speed, wind direction, and rainfall.

The readout panel is shown in figure 2-8. It has digital LED readouts for time, air temperature, dew-point temperature, maximum and minimum temperatures, wind direction and speed, pressure, and rainfall. The panel is also equipped with a digital voltmeter.

Some of the LED readouts are not in operation. Because of the pressure sensor system's age and inaccuracy, this feature is no longer used. The wind direction and wind speed display provides a 14- to 16-second averaged wind speed; this 14- to 16-second

update is not up to current meteorological standards. The time display, which indicates coordinated universal time (UTC), is not always accurate; therefore, a supplemental clock for time reference may be used.

The air temperature, dew-point temperature, and maximum- and minimum-temperature readouts, provided in degrees Fahrenheit, are reliable and are used as the primary source for these observation readings. Switches in the controller drawer are used to reset the maximum and minimum temperatures.

The accumulated precipitation readout, in inches, tenths, and hundredths of an inch, is also reliable. The precipitation readout is reset to zero by using the reset switch in the front of the controller drawer.

The RO-447/GMQ-29 analog recorder has been disconnected or turned off on most units. The RD-108/UMQ-5 analog recorder is the primary equipment used for evaluation of wind speed and direction. The RD-108/UMQ-5 is discussed later in this chapter.

Now let's look at the AN/GMQ-29 sensor group.

SENSOR GROUP

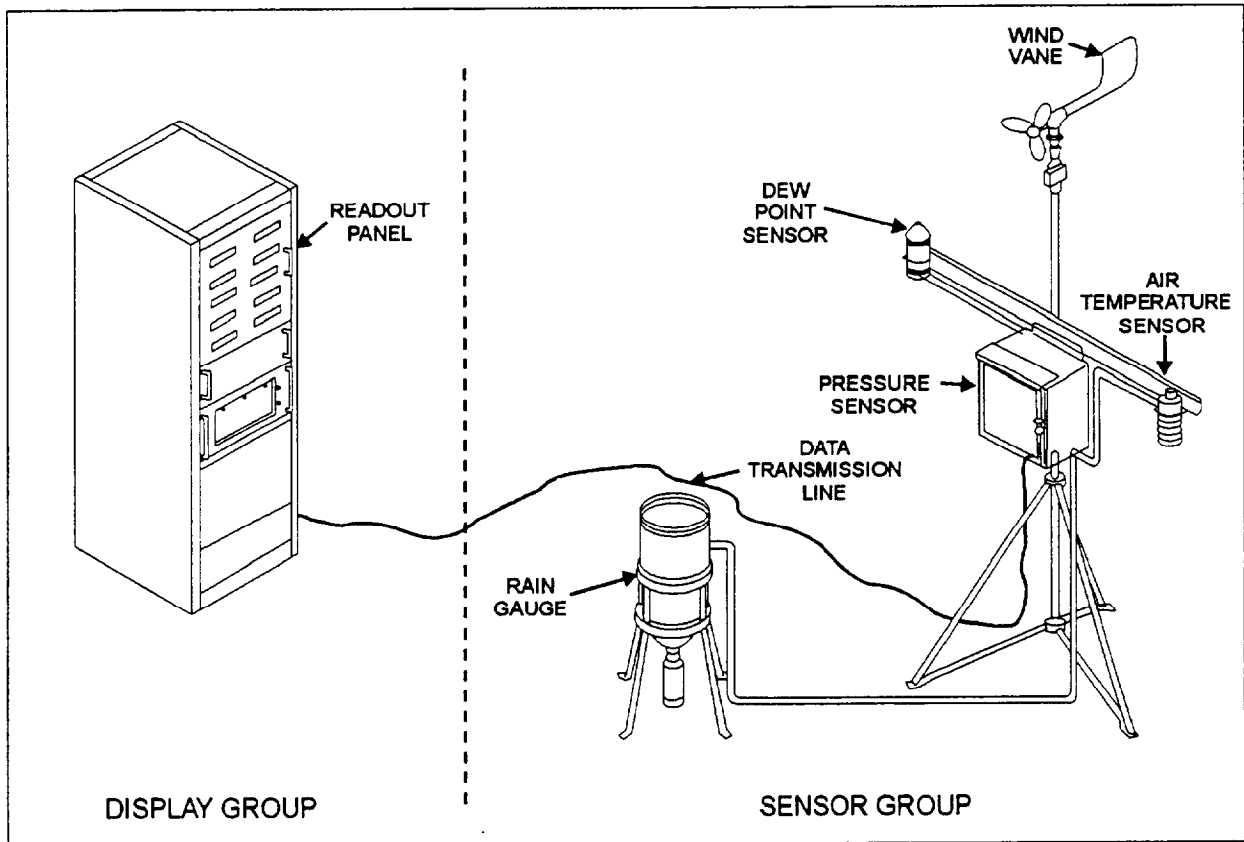
The AN/GMQ-29 sensor group is located outside the building, usually near the most active runway. Several sensor groups may be used with a single display group. The sensor group consists of the following units:

- ML-400/UMQ-5 wind transmitter
- ML-643/GMQ-29 dew-point sensor
- ML-641/GMQ-29 air temperature sensor
- ML-642/GMQ-29 pressure sensor
- ML-588/GMQ-14 tipping-bucket rain gauge

The AN/GMQ-29 weather station is shown in figure 2-9. The sensor group inputs are connected to the display group through a data transmission line. This equipment is maintained by base ground electronics personnel. Only the temperature sensors and rain gauge are currently used with most GMQ-29 systems. First, let's look at the air temperature and dew-point sensors, and then discuss the rain gauge.

Dew-point and Air Temperature Sensors

The ML-641/GMQ-29 air temperature sensor is shown in figure 2-10. The sensor consists of a resistance element probe mounted in an enclosure. The enclosure shields the sensor from solar radiation and precipitation, yet allows a free flow of air.



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Figure 2-9.—AN/GMQ-29 weather station.

Figure 2-11 shows the ML-643/GMQ-29 dew-point sensor. The sensor consists of a heated resistance probe mounted inside a shield to protect it from rain, wind, and solar radiation.

Tipping-Bucket Rain Gauge

The ML-588/GMQ-14 tipping-bucket rain gauge collects rainwater and funnels it to two small cuplike

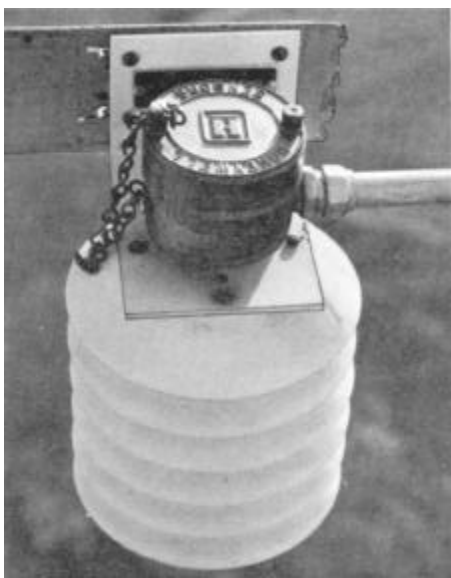


Figure 2-10.—ML-641/GMQ-29 air temperature sensor.



Figure 2-11.—ML-643/GMQ-29 dew-point sensor.

“buckets” (see figure 2-12). Each bucket automatically dumps when filled with the equivalent of 0.01 inch of liquid precipitation. The tipping of each bucket activates a mercury switch, which sends a signal to the display controller. The display controller indicates total rainfall on the display and a “step” on the right edge of the RD-108/UMQ-5 analog recorder chart for each “tip” of a bucket.

The tipping buckets normally dump measured water into a second collecting funnel. The funnel has a drain cock at its base, which is used to drain the collected water into a measuring cylinder. The valve is normally left in the open position with the measuring cylinder removed.

You should check the rain gauge frequently to ensure that no foreign objects or dirt is clogging the funnel or the small cuplike buckets. You should also inspect for signs of corrosion.

So far we have discussed only some of the more modern, high-technology electronic equipment used in surface weather observations. Most of the equipment discussed in the following text are not nearly as sophisticated. However, much of the instruments are still retained as back-up equipment because of their simple design and reliability. The instrument shelter is surface weather observation equipment of this type.

REVIEW QUESTIONS

- Q6. What are the two major equipment groups of the AN/GMQ-29?

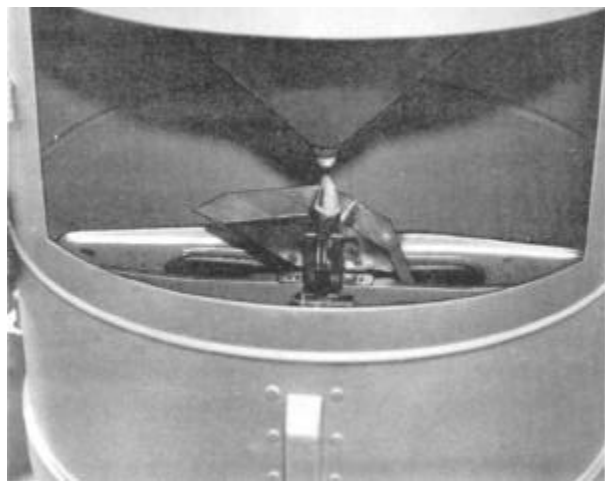


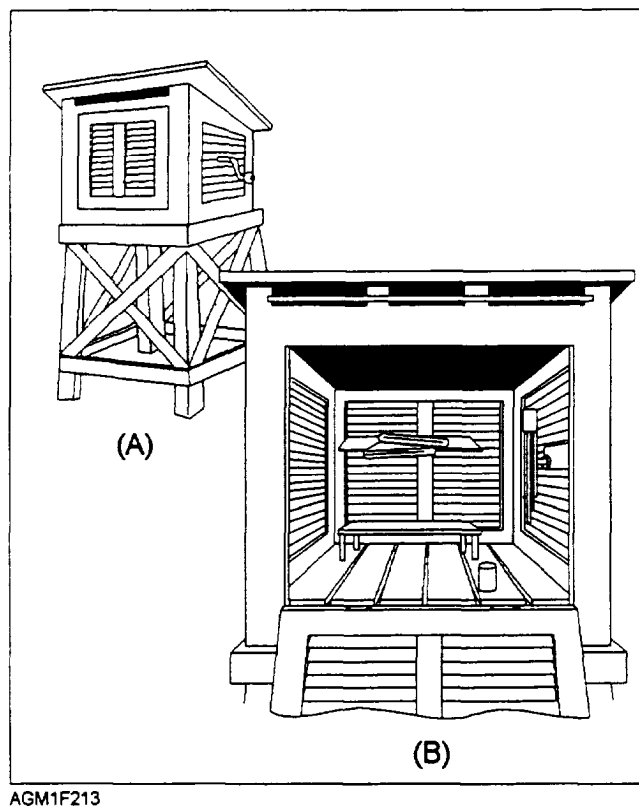
Figure 2-12.—ML-588/GMQ-14 tipping-bucket rain gauge, with the door open showing the twin tipping buckets.

- Q7. What information is shown on the AN/GMQ-29 display panel?
- Q8. How are sensor group inputs sent to the display group?

INSTRUMENT SHELTER

LEARNING OBJECTIVES: State the purpose of the ML-41 equipment shelter. Describe the routine care required for the shelter.

The ML-41 instrument shelter, shown in figure 2-13, is still in use at many Naval and Marine Corps stations. The shelter is used for the protection and acclimatization of “backup” observation equipment. The shelter is constructed of wood, which is a poor transmitter of heat. It has a louvered door and sides, as well as a double-layered, sloping roof. This type of construction helps keep out water and sunlight, yet allows a free flow of air through the structure. These shelters are always painted white to help reflect sunlight and infrared radiation.



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Figure 2-13.—Standard instrument shelter. (A) Construction of support; (B) instrument arrangement inside shelter.

Proper care and maintenance of the shelter is described in NAVAIR 50-30FR-518, *Operation and Maintenance, Standard Air, Maximum and Minimum Thermometers, Townsend Support, Sling and Rotor Psychrometers, and Instrument Shelters*. The routine care of the shelter includes keeping it free of dirt and debris and oiling the door hinges.

Backup equipment usually kept inside the shelter includes the rotor, sling or electric psychrometers, and maximum and minimum thermometers mounted on a Townsend support. When the temperature is above freezing, a bottle of distilled water is also included for the psychrometers.

REVIEW QUESTIONS

- Q9. What is the purpose of the ML-41 instrument shelter?
- Q10. What tasks are included in the routine care for the instrument shelter?

THERMOMETERS

LEARNING OBJECTIVES: Describe the characteristics of liquid-in-glass thermometers. Explain how to properly read a thermometer. Identify three types of liquid-in-glass thermometers.

Liquid-in-glass thermometers, such as alcohol or mercury thermometers, are found throughout the Navy and Marine Corps in various configurations. Some are simply closed glass tubes mounted on a graduated cardboard, plastic, or metal backing, and others have the graduations etched into the glass. For meteorological and oceanographic readings, calibrated thermometers with the graduations permanently etched into the glass are recommended, since they are considered the most accurate.

In meteorology and oceanography, liquid-in-glass thermometers are used in the rotor psychrometer, the sling psychrometer, electric psychrometers, and as simple thermometers for measuring seawater temperature by the bucket method. The maximum and minimum thermometers found in the instrument shelter are special types of liquid-in-glass thermometers. Both NAVMETOCCOMINST 3141.2 and NAVMETOCCOMINST 3144.1 provide detailed instructions for use and care of the different types of thermometers.

READING A THERMOMETER

Accuracy is the goal when making any temperature reading. To obtain an accurate reading, you must read the thermometer properly. Be sure the thermometer is clean, and allow the instrument to acclimatize prior to reading. Keep the following points in mind when reading temperatures:

- The temperature indicated by a liquid-in-glass thermometer should be read to the nearest 1/10 of a degree at the top of the meniscus, with the eye looking straight at the fluid level (fig. 2-14) to avoid parallax error.

- Avoid obvious scale errors in reading. Errors of 5 or 10 degrees are more common than errors of 1 or 2 degrees.

- Do not allow any moisture to accumulate on a dry-bulb thermometer. Protect the thermometer from spray and precipitation.

- Do not hold a thermometer too close to your body or near a heat source, such as a light bulb or direct sunshine. Always stand downwind of a thermometer.

- When the air temperature is below freezing, wait at least 15 minutes after wetting the wet-bulb wick before using a wet-bulb thermometer. This allows the water to freeze on the wick to prevent false high readings.

ROUTINE CARE

Routine care of thermometers is limited to keeping the glass clean. When using a thermometer to measure wet-bulb temperature, keep the cotton wick clean. A weekly wipe down of glass thermometers with freshwater is usually sufficient. At sea, especially under windy conditions, minute salt crystals tend to accumulate on the thermometers. These crystals readily

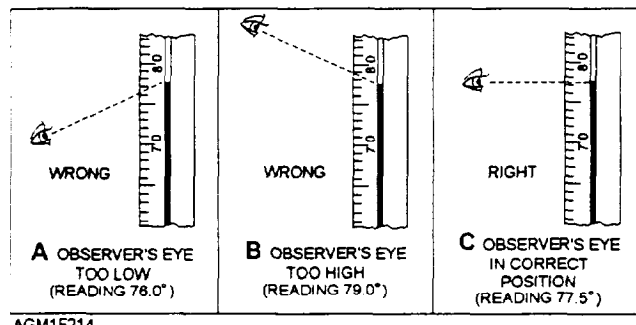


Figure 2-14.—Reading a thermometer to avoid parallax error.

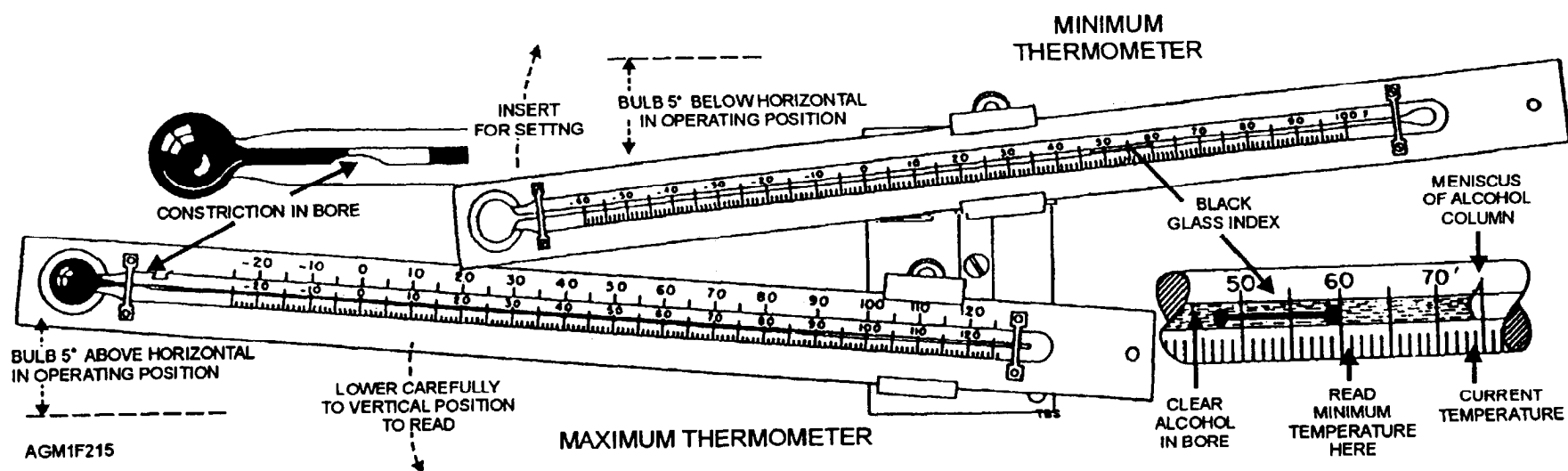


Figure 2-15.—Maximum and minimum thermometers mounted on a Townsend support.

attract moisture, which evaporates when the thermometer is ventilated. Evaporation will yield false low readings. A daily cleaning of the thermometers may be necessary in this situation.

Changing the wick on wet-bulb thermometers should be done weekly aboard ship and monthly ashore. The procedure is detailed in NAVAIR 50-30FR-518.

ALCOHOL THERMOMETERS

Alcohol thermometers may be used to measure temperatures from -115°C (freezing point of alcohol) to 785°C (boiling point of alcohol). The standard thermometer for environmental measurements need only cover the range -20°F to 120°F , or about -30°C to 50°C .

Because alcohol is a volatile fluid, the column in the thermometer frequently becomes separated by mechanical shock. The column may be reunited by dropping the thermometer on a wood surface that is covered with several sheets of paper. Hold the thermometer in a vertical position, bulb end down, 4 to 6 inches over the wood surface covered with paper, and then drop. After the thermometer bulb strikes the paper, catch the thermometer with your other hand to prevent breakage. Small amounts of alcohol may cling to the portion of the capillary tube above the alcohol column. Heating the high-temperature end of the thermometer under an incandescent light may force the alcohol back to the column. Allowing the thermometer to stand in a vertical position overnight will also allow the alcohol to drain down to the column. Do not use a thermometer with a separated fluid column; it will give you inaccurate readings.

MERCURY THERMOMETERS

Recently, several Naval Headquarters have recommended that alcohol thermometers be used in place of mercury thermometers when possible. NAVSEAINST 5100.3, *Mercury, Mercury Compounds, and Components Containing Mercury or Mercury Compounds; Control of*, identifies mercury as a toxic substance that requires special handling and control. Overboard discharge of any amount is prohibited. This instruction also defines mercury-spill decontamination requirements and mercury-handling requirements.

WARNING

Liquid or vaporous mercury is a hazardous material. It is toxic to humans and most forms of marine life, and is highly corrosive to electronic components.

The use of mercury thermometers in sling psychrometers is strongly discouraged, since users of sling psychrometers sometimes strike objects during the spinning operation, breaking the glass and releasing mercury. The release of even a small amount of mercury from a broken thermometer is a "mercury spill," which must be handled in accordance with NAVSEAINST 5100.3. Unbroken mercury thermometers, either in use or in storage, are classified "functional mercury" and are subject to shipboard mercury inventory reporting as directed by NAVSEAINST 5100.3.

Separated mercury columns in thermometers should be rejoined by slowly heating the thermometer bulb under an incandescent lamp. Withdraw the thermometer from the heat source as the mercury approaches the top of the thermometer. Then, carefully control the heating so that the mercury rises slowly in the column and just reaches the end of the thermometer. Overheating at this point will cause the mercury to expand until it ruptures the thermometer, resulting in a spill. Allow the thermometer to cool; the columns of mercury should rejoin as the mercury recedes.

MAXIMUM AND MINIMUM THERMOMETERS

Maximum and minimum thermometers are alcohol-filled thermometers mounted on a Townsend support inside an instrument shelter. These thermometers are strictly backup equipment for the maximum and minimum temperature function of automatic and semiautomatic observation systems. Proper use and care are detailed in NA 50-30FR-518. Figure 2-15 shows the instruments mounted on the Townsend support, and figure 2-16 shows the detail of the Townsend support.

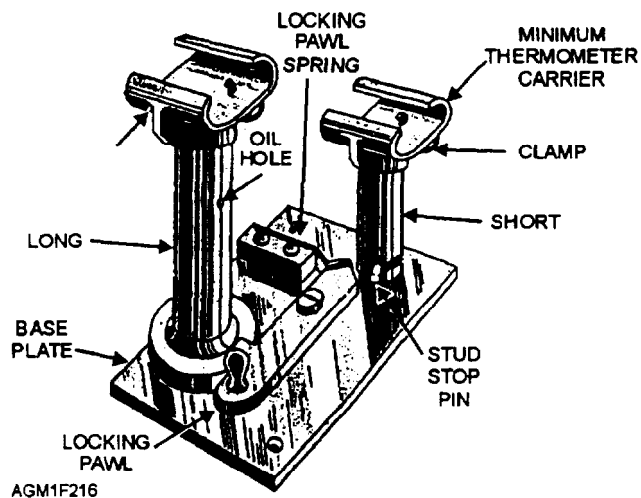


Figure 2-16.—ML-54 Townsend support details.

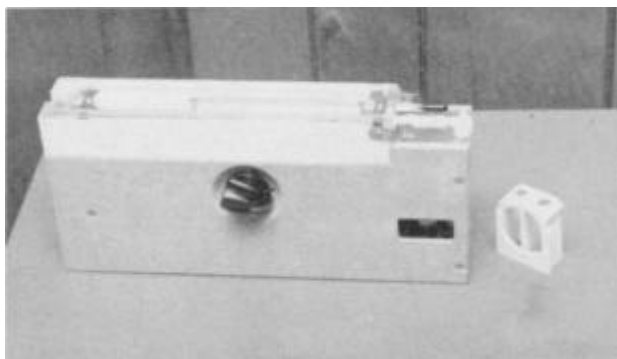


Figure 2-17.—A typical electric psychrometer.

We have just covered several types of simple thermometers. Most frequently, the thermometers used by Aerographer's Mates are found in psychrometers.

REVIEW QUESTIONS

- Q11. *What are the two primary liquids found in thermometers?*
- Q12. *Where can you find detailed instructions for use and care of the different types of thermometers?*
- Q13. *How should the temperature be read from a liquid-in-glass thermometer?*
- Q14. *How often should the wick on a wet-bulb thermometer be changed aboard ship?*
- Q15. *What instruction outlines procedures to be followed in the event of a mercury spill?*

PSYCHROMETERS

LEARNING OBJECTIVES: Define psychrometer. Explain the care and use of the electric, sling, and rotor psychrometers.

A psychrometer is any device that contains both a dry-bulb and a wet-bulb thermometer used to measure ambient air temperature and wet-bulb air temperature. Currently there are three different types of psychrometers used by the Navy and Marine Corps: the electric psychrometer, the sling psychrometer, and the rotor psychrometer.

ELECTRIC PSYCHROMETER

Electric psychrometers are used aboard some ships as the primary air temperature/wet-bulb temperature-measuring device. They are kept on hand at all shore observation sites as a backup for automatic air temperature and dew-point sensors. There are several slightly different models of electric psychrometers in use: the ML-450/UM and the ML-450(A)/UM through the ML-450(D)/UM models, and the "Type III" electric psychrometer. Figure 2-17 shows a typical electric psychrometer. All models contain a dry- and a wet-bulb thermometer, a small, battery-operated electric fan, several batteries, thermometer illumination lights, and a small distilled-water bottle.

Electric psychrometers should be allowed to acclimatize to the ambient conditions if kept inside an office space, especially during extremely cold or hot weather. When the outside air temperature is cooler than 50°F or warmer than 85°F, allow the psychrometer to sit in a sheltered outside area 5 to 10 minutes before using. When the air temperature is below freezing, wet the wick and allow the psychrometer to sit 15 minutes before using, to allow the wick to freeze.

To avoid acclimatization time, many shipboard observers store the psychrometer outside in a sheltered location. You must take care to ensure that the psychrometer is held securely in the storage location to prevent breakage from the ship's motions. Ashore, the electric psychrometers are usually stored outside in the instrument shelter.

To use the electric psychrometer properly, wet the muslin wick with a few drops of distilled water from the bottle. Then, stand on the windward side of the ship or building with the air intake pointed toward the wind, turn the fan motor on, and hold the psychrometer at arm's length. The scale lights should be turned on only when you read the temperatures. After 60 seconds, read the wet-bulb temperature at 10-second intervals until the temperature reads the same for two consecutive readings. Record both the wet- and dry-bulb temperatures to the nearest 1/10 degree. Then, turn the fan motor off.

When issued, each electric psychrometer is supplied with a use, care, and maintenance handbook. Routine care and maintenance of the electric psychrometer include changing the wet-bulb wick, keeping the psychrometer clean and dry, and changing the batteries and light bulbs. Cleaning and lubrication of the electric motor are also required. For more

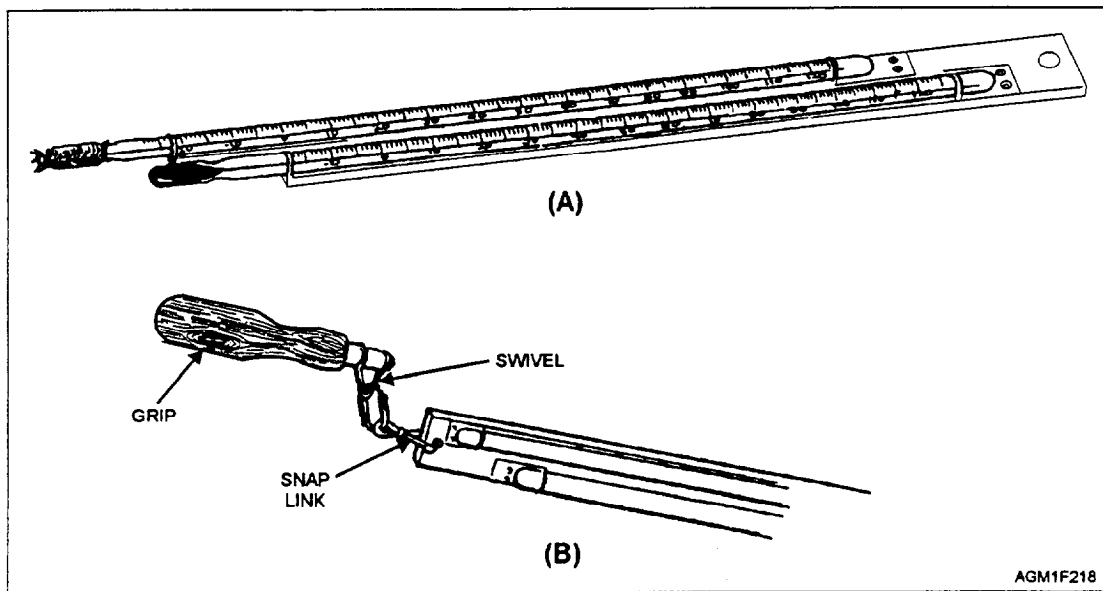


Figure 2-18.—Psychrometer: (A) Standard sling psychrometer; (B) with sling attached.

detailed instructions, refer to the handbook supplied with the equipment.

SLING AND ROTOR PSYCHROMETERS

Sling psychrometers (fig. 2-18) are used to backup the electric psychrometers, both ashore and aboard ship. Because of the widespread use of electric psychrometers, sling psychrometers are rarely used. Rotor psychrometers (fig. 2-19), mounted inside the standard instrument shelter ashore, are also rarely used as backups. Use, care, and maintenance instructions are found in NA 50-30FR-518.

REVIEW QUESTIONS

- Q16. Name the three types of psychrometers used by the Navy?
- Q17. Explain the proper use of an electric psychrometer.
- Q18. What tasks are included in the routine care of electric psychrometers?

PRESSURE INSTRUMENTS

LEARNING OBJECTIVE: Describe the operation of the precision aneroid barometer and the marine barograph.

Pressure-measuring instruments are critical equipment for surface weather observations. The ML-448/UM precision aneroid barometer is still the primary

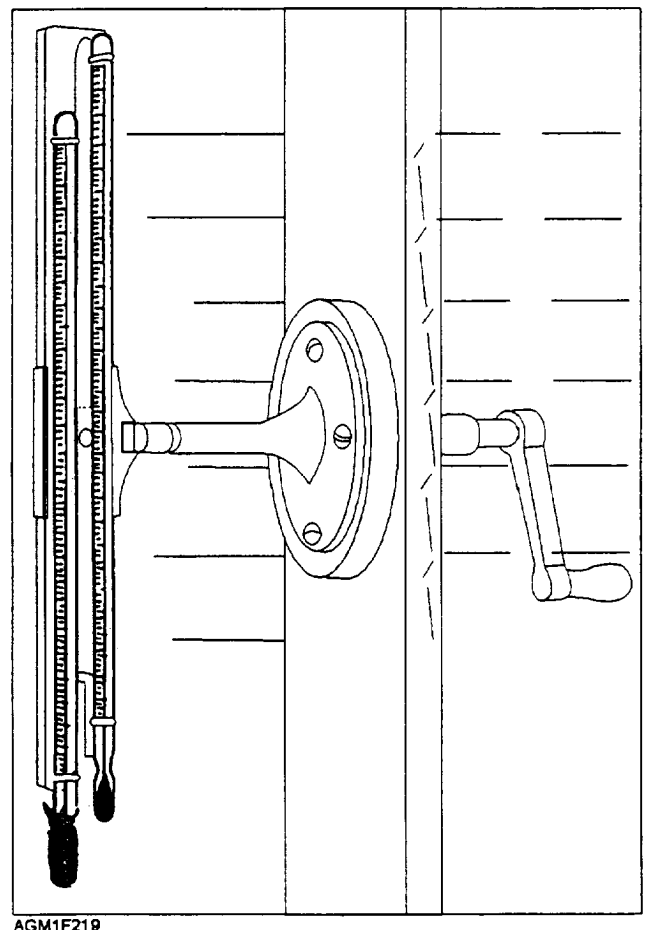


Figure 2-19.—Rotor psychrometer.

pressure-measuring instrument at some stations. Many shore stations also have a Navy digital altimeter setting indicator (NDASI or DASI).

The Automated Surface Observing System (ASOS) equipment also provides pressure readings and becomes the primary pressure-measuring instrument as it is installed. Then, the ML-448/UM aneroid is retained as a backup instrument. Use of the NDASI may be discontinued.

PRECISION ANEROID BAROMETER

The ML-448/UM precision aneroid barometer is shown in figure 2-20. The barometer is mounted in either a brass case or a black, hard, plastic case.

The precision aneroid barometer is designed to accurately indicate atmospheric pressure in inches and hectopascals (hPa). The pressure element is a Sylphon cell, which consists of a sealed, bellows-shaped canister that expands and contracts with changes in air pressure.

Gears and linkage arms transfer changes in size of the Sylphon cell into indicator movement. The gears and linkage also correct the movement for changes in temperature. The ML-448/UM has a range from 910 hPa (26.9 inches) to 1,060 hPa (31.3 inches), with an acceptable accuracy of ± 1.0 hPa.

Precision aneroid barometers must be calibrated twice a year when used aboard ship, and once a year when used at shore stations. Basic guidance for the barometer calibration program is provided in NAVMETOCCOMINST 13950.3, *Naval Meteorology and Oceanography Command Barometer Calibration Program*.

Instructions for use of aneroid barometers during a surface aviation observation are provided in both NAVMETOCCOMINST 3141.2 and NAVMETOCCOMINST 3144.1. To obtain a proper pressure reading using any aneroid barometer, use the following steps:



Figure 2-20.—ML-448/UM precision aneroid barometer.

1. Tap the face of the barometer lightly with your finger to reduce the effects of friction.
2. Look straight at the indicator to avoid parallax error. On the ML-448/UM, align the indicator arm directly over the reflection on the mirrored surface of the scale.
3. Read the scale to the nearest 0.005 inch or 0.1 hPa to obtain barometric pressure.
4. Apply any posted correction.
5. Add the appropriate removal correction.

NAVY DIGITAL ALTIMETER SETTING INDICATOR (DASI)

The Navy Digital Altimeter Setting Indicator (DASI), shown in figure 2-21, is located at most Naval meteorology and oceanography detachments and Marine Corps weather stations. The DASI has an electronic pressure-sensing element, and the altimeter values are displayed on a digital LED readout panel. The panels are located both in the observer's spaces and in the control tower. NAVEXEM-450-AA-OMI-010-DASI, *Operation and Maintenance Instructions, Digital Altimeter Setting Indicator (DASH)*, is the operator's manual for this system. It may be held by the air traffic controllers.

The DASI should not be used as a pressure-measuring instrument. Use of the DASI should be discontinued when the altimeter setting indicated by the instrument exceeds the altimeter setting computed from readings from the ML-448/UM by more than ± 0.02 inch.

Unless a Space and Naval Warfare Systems Command (SPAWARSYSCOM) certified calibration procedure for the DASI pressure sensor is developed in the near future, the DASI is expected to be taken out of service when ASOS is completely installed.

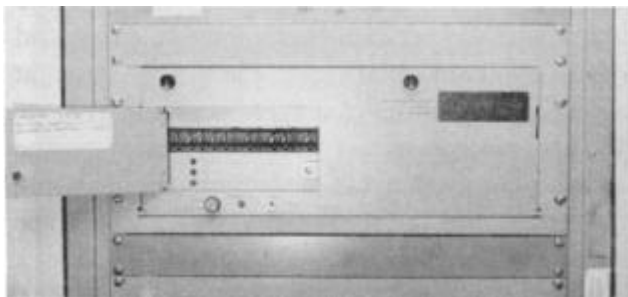


Figure 2-21.—Navy digital altimeter setting indicator (DASI).

MARINE BAROGRAPH

Barographs are instruments used to record or graph atmospheric pressure over a period of time. The marine barograph is the only type of barograph found throughout the Navy and Marine Corps. It is suitable for use aboard ship and at shore stations. The marine barograph has not been assigned a military reference designator.

Barographs are primarily used to determine 3-hour pressure tendencies for surface aviation weather observations. Appendix IV shows general barograph trace patterns used to determine the nine reportable pressure tendencies. Stations not equipped with a barograph may report a simplified tendency based on recorded pressures over a 3-hour period.

The marine barograph (fig. 2-22) is a precision instrument that measures air pressure either in the immediate vicinity or at a remote point outside the ship. The instrument is highly sensitive to changes in pressure and has linkages that accurately compensate for changes in temperature. The instrument maintains its precision aboard ship by the use of an adjustable, grease-filled, dampening cylinder that cancels out shipboard vibrations and the pitch or roll of the ship. Since the air pressure inside a ship may be different from the outside air pressure (especially when material condition Yoke or Zebra is set), shipboard marine barographs should be connected to the outside air. Shipboard marine barographs are connected to the exterior of the ship through use of a flexible rubber hose connected to a fitting on the barograph case.

The marine barograph is equipped with a "magnified scale" for recording pressure. The recording chart scale ranges from 965 to 1,050 hPa, but the instrument has a total usable range from 915 to 1,085 hPa. To prevent the pen arm from recording off the edge of the chart, you should adjust the pen arm upward on the scale by 40 hPa during periods of extremely low pressure, or downward on the scale by 40 hPa during periods of extremely high pressure. The adjustment is made by turning the adjustment knob. Because of the magnified scale, high sensitivity, and accurate temperature compensation, the marine barograph is sometimes called a "microbarograph."

Operation

NA 50-30BIC-1, the *Handbook of Operation, Service, and Overhaul Instructions for the Marine Barograph*, provides detailed instructions for the

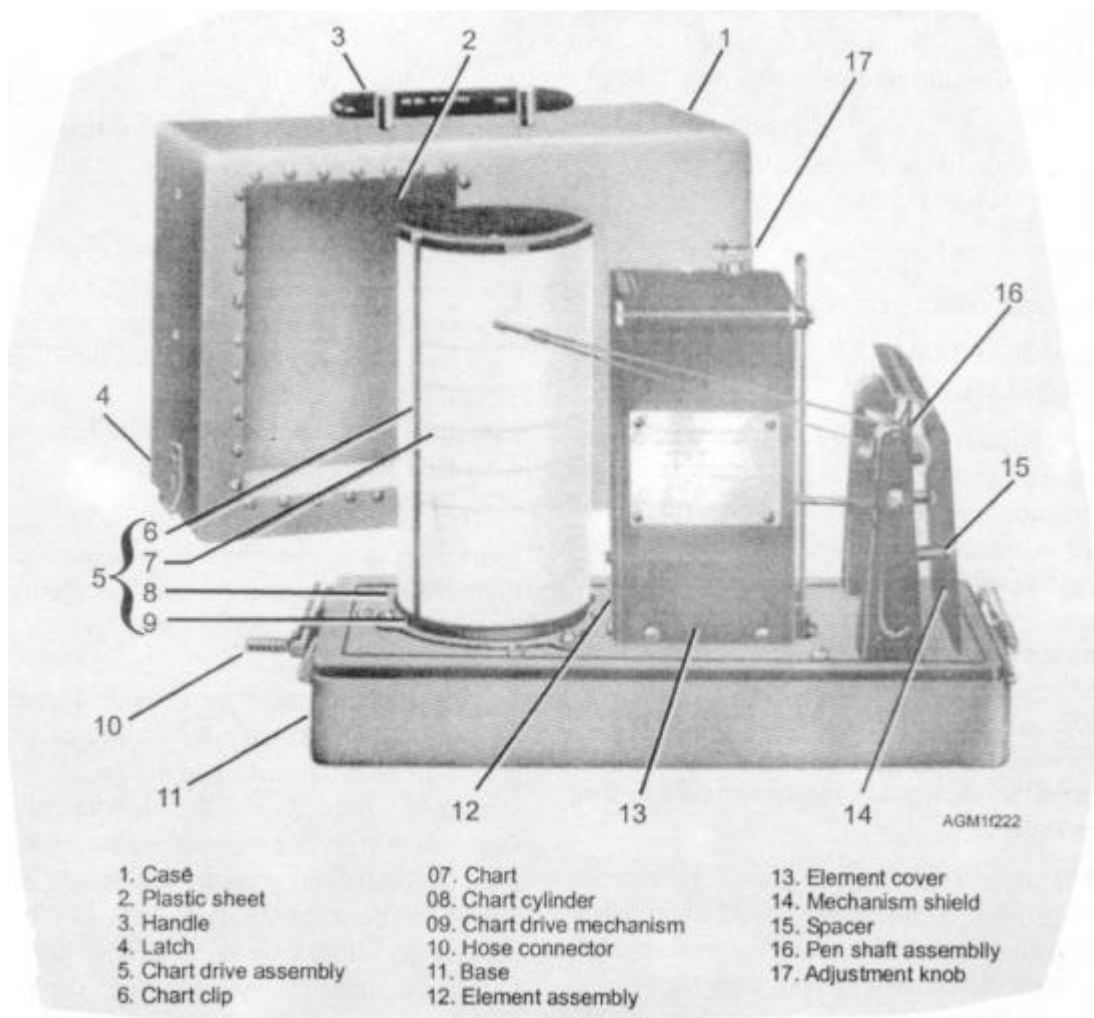


Figure 2-22.—Marine barograph.

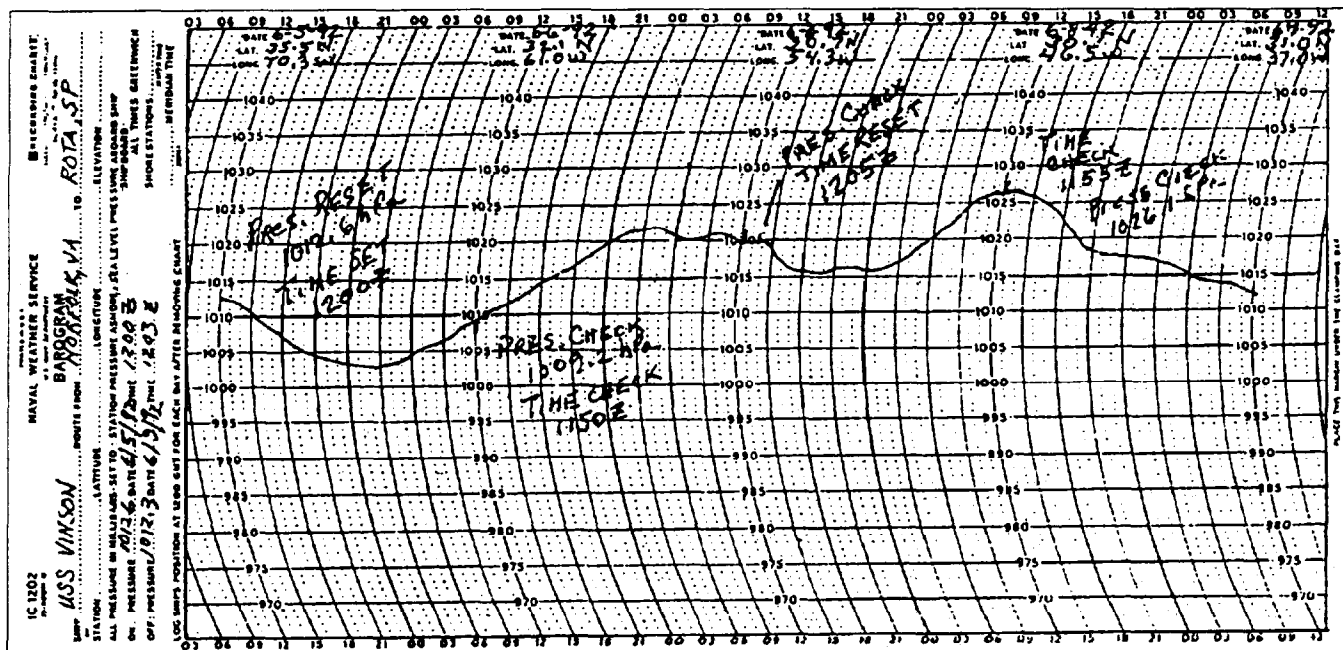
proper use and maintenance of the equipment. NAVMETOCCOMINST 3144.1 also provides guidance on replacing charts, rewinding the clock, conducting time and pressure checks, and making other adjustments.

REPLACING THE CHART.—Charts (fig. 2-23) should be replaced every 4 days at 1200 UTC (and on the first day of each month). Fill in as much of the chart identification data as possible before placing the chart on the barograph. All time should be set and entered in UTC. Add the station elevation to the nearest foot if a space is not already provided on the chart. Lift the pen arm from the chart and remove the chart cylinder from the barograph. Remove the old chart, and then place the new chart on the cylinder. The trailing edge of the pressure/time graph should overlap the chart Identification-Data section, and the edge of the paper

should be aligned under the metal spring clip. Complete the entries on the old chart for ship's position, date, and (chart) off pressure, date, and time. Rewind the clock mechanism.

REWINDING THE CLOCK.—Although the clock has an 8-day mechanism, it should be rewound every 4th day, when replacing the chart. Seven to eight pulls on the lever inside the cylinder is sufficient to rewind the mechanism. Place the cylinder on the barograph; align the correct time line with the pen point; and lower the pen point onto the chart. Check the pressure.

REINKING THE PEN.—A glass rod is used to transfer a drop of purple recording ink to the pen tip. Very little ink is needed, and the pen is considered adequately inked if the pen tip cavity is half full. The



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Figure 2-23.—Marine barograph chart.

ink is hygroscopic and will absorb moisture from the air. When the ink becomes too diluted from absorbed moisture, the trace will appear “washed-out.” When this happens, remove the pen tip, rinse it in freshwater, blow it dry, replace it on the pen arm, and reink the pen. A wide pen trace indicates a dirty or damaged pen tip. Clean and reink or replace the tip as appropriate.

Accuracy Checks and Adjustments

Time and pressure checks are completed at each synoptic and intermediate synoptic hour, after reading the 3-hour pressure tendency. At synoptic observation times, touch the pen arm lightly to make a “tic” mark in the pressure trace for time checks. Time adjustments are required when the time is in error by 15 minutes or more, and pressure adjustments are recommended when the pressure is off by 1.5 hPa or more.

TIME ADJUSTMENTS.—Time adjustments are made by rotating the chart cylinder until the pen is marking at the correct time. A time correction entry should be made on the chart, consisting of an arrow pointing to the corrected time, the remark “Time Reset,” and the correct UTC time, such as 1155Z. Remarks may be made directly on the mounted chart or entered on a note pad or clipboard near the barograph. If the remarks aren’t made directly on the chart, they should be transferred to the chart after it is removed.

PRESSURE ADJUSTMENTS.—Pressure adjustments are made by turning the adjustment knob. Draw an arrow to the correct pressure and enter the remark “Pres. Reset,” along with the UTC time, on the chart.

REVIEW QUESTIONS

- Q19. How often should the aneroid barometer be calibrated?
- Q20. What procedure should you use to obtain a reading from an aneroid barometer?
- Q21. In what situation should the altimeter setting of the DASI not be used?
- Q22. What device enables the marine barograph to maintain its precision aboard ship?
- Q23. When should the chart on the marine barograph be replaced, and what time should it be coordinated with?
- Q24. Rewinding the clock of the marine barograph requires approximately how many pulls if completed after every fourth day.
- Q25. What criteria is used for time and pressure adjustments on the marine barograph?

ANEMOMETER SYSTEMS

LEARNING OBJECTIVES: List three types of wind-measuring instruments and describe the operation and maintenance of each type.

Three types of certified wind-measuring systems or anemometers are widely used throughout the Navy and Marine Corps. These are the AN/UMQ-5 wind-measuring set, used at shore locations; the Type B-3 wind-measuring system, used aboard ships; and the backup, hand-held AN/UMQ-3 anemometer. All of these systems are used to accurately measure wind speed, in knots, and to indicate the direction from which the wind is blowing.

The AN/UMQ-5 system is being replaced by the new sensors and transmitters in the ASOS equipment package. The shipboard Type B-3 system sensors and transmitters will continue to be used although the

information will be displayed on the SMOOS display terminal. The reliable AN/PMQ-3 hand-held anemometer is expected to be kept as a backup system for a very long time.

AN/UMQ-5 WIND-MEASURING SYSTEM

The basic equipment of the AN/UMQ-5 has changed very little since its introduction to the fleet in the late 1940's. However, there have been several modifications that added equipment to the system and updated the electronics. The newest modification is the AN/UMQ-5(D), introduced in 1959. A typical system is shown in figure 2-24. A single system may use one or more ML-400/UMQ-5 transmitters, and drive up to six different indicators or recorders. The primary recorder is the RD-108/UMQ-5. ID-300/UMQ-5 indicators and ID-586/UMQ-5 indicators are frequently used with the system.

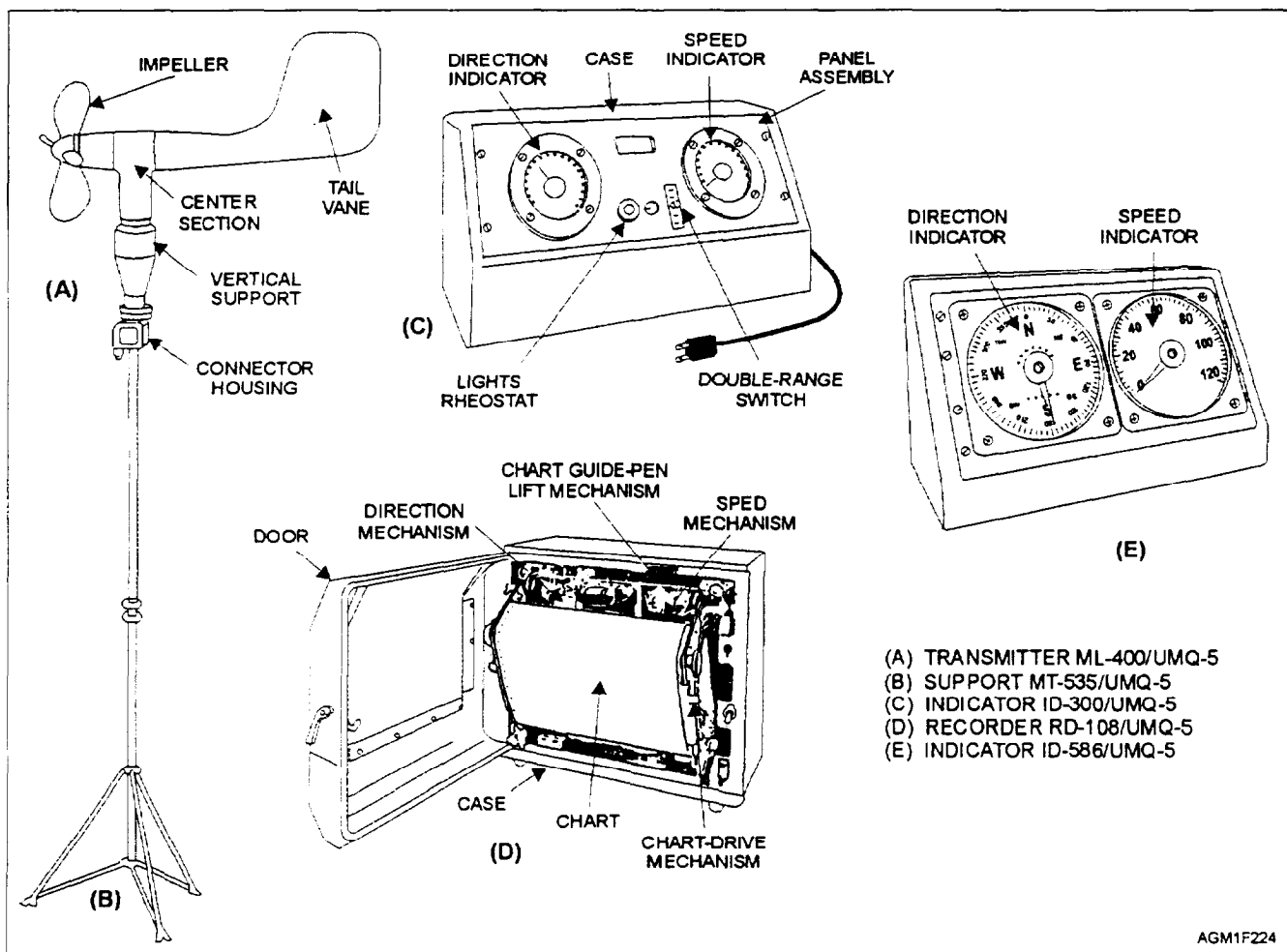


Figure 2-24.—AN/UMQ-5 wind-measuring set.

NOTE: The ID-2447/U indicator (fig. 2-25) is a recent addition to the UMQ-5 system. The indicator is found in weather offices and in Marine Corps radar support spaces, with the primary readout in the Air Traffic Control Center. The indicator provides average, minimum, and maximum wind speeds. For more information on the ID-2447/U indicator, see the operating and maintenance instructions.

Typically, the wind speed and direction indicators and wind speed recorders are installed inside the weather office, while the transmitter is installed on an MT-535/UMQ-5 support mast near the runway or on a rooftop.

Operation and Maintenance

Operation and maintenance instructions for the different components of the AN/UMQ-5 wind-measuring set are detailed in several manuals. Consult the manual for the model installed in your office. NA 50-30FR-525, the *Handbook of Operation and Maintenance Instructions for Wind Measuring Sets AN/UMQ-5C and AN/UMQ-5D*, covers the newer models, including instructions for the later model RD-108(B) chart recorders. NA 50-30FR-501 covers the AN/UMQ-5(A) system, and NA 50-30FR-512 covers the AN/UMQ-5(B) system. Instructions for the older model recorders (RD-108/UMQ-5 and RD-108(A)/UMQ-5) are covered in NA 50-30FR-505, the *Handbook of Operation and Service Instructions for the Wind Direction and Speed Recorder RD-108/UMQ-5*.

TRANSMITTERS AND INDICATORS.—Very little operator attention is required for this equipment. The operator's handbook recommends a daily visual check of the transmitters and indicators, and a weekly

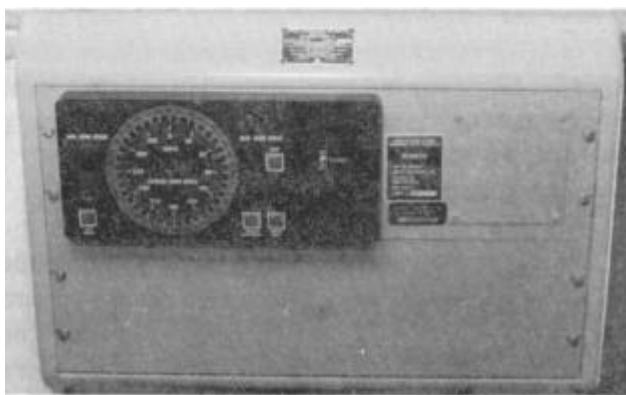


Figure 2-25.—ID-2447/U wind speed and direction indicator.

visual inspection of the transmitter. Jerky movement of the impeller or failure of the wind vane to follow light winds indicates an overhaul is due. Finally, a quarterly friction check is recommended. The transmitter is removed and bench tested with penny and half-dollar weights to check for excessive friction.

WIND RECORDER.—The analog wind recorder requires somewhat more attention. The recorder pens mark a continuous output of wind direction and wind speed on a continuous, two-column chart (fig. 2-26). The wind direction column, on the left side of the chart, has vertical lines drawn for every 10 degrees; these are labeled every 90 degrees, along with the cardinal compass points. The chart covers 540 degrees to allow for shifting winds. The wind speed column, on the right side, has vertical lines drawn every 2 knots; these are labeled every 20 knots, from 0 to 120 knots. Curving lines across the chart mark the time every 10 minutes and are labeled for every hour, in the center divider strip.

Many recorders have been modified to use preinked pen cartridges, which are simply replaced as a unit when the ink runs dry. Some units still use the older model pens and inkwells. The older pens must be checked frequently; a line that skips on the chart usually indicates a dirty pen.

A standard, 100-foot, wind speed and direction recorder chart, when operated at the standard speed of 3 inches per hour, will run for 15 to 16 days before it requires changing. Instructions on how to replace the chart in the recorder are contained in the handbook on operation and maintenance.

Recorder Charts

The analog recorder charts should be carefully preserved and treated as a permanent official record. Each recorder chart roll should be identified at the start and end of the roll, with the station name and the date and time the recording began and ended. The chart is adjusted so the times marked on the chart correspond to UTC. The chart should be changed at 0000 UTC on the first day of each month and at intermediate times to prevent the loss of data. See NAVMETOCCOMINST 3141.2 for more information.

TIME CHECKS.—Time checks are made on the recorder chart by drawing a short line on the recorder chart where the pen is marking data, and entering the date and time to the nearest minute. At the minimum, time checks are required as follows:

- At the beginning and end of each chart roll

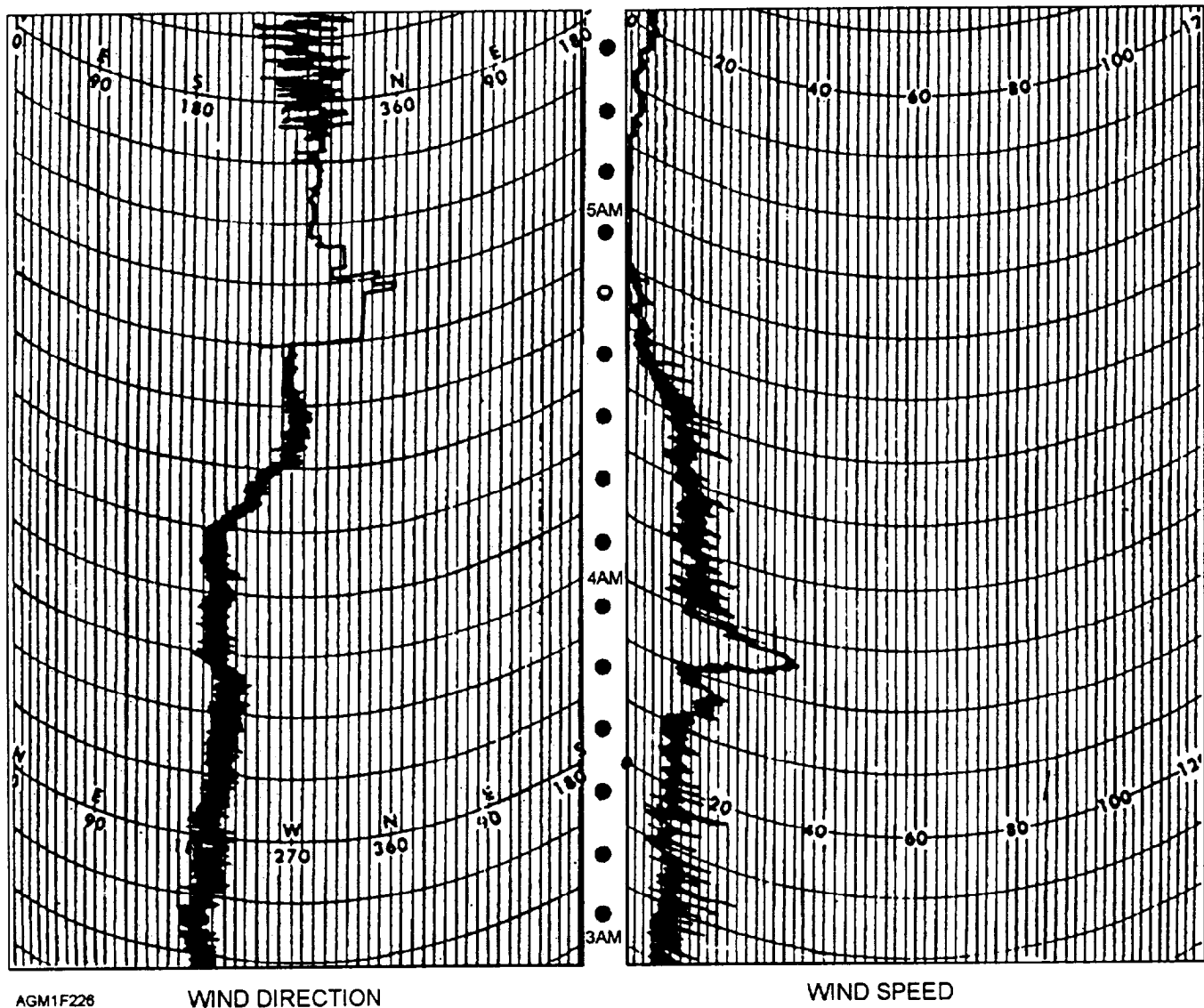


Figure 2-26.—RD-108/UMQ-5 recorder chart

- Near the time of each synoptic hour (0000Z, 0600Z, 1200Z, and 1800Z)
- When notified of an aircraft mishap
- For each disruption or discontinuity in the trace; for instance, when returning the equipment to service after a power outage or maintenance downtime
- At the time of the first observation of the day when the station does not operate for 24 hours a day

TIME ADJUSTMENTS.—Time adjustments must be made whenever the time error is more than 5 minutes. Draw an arrow to the adjusted time, and then enter "Time Corrected," followed by the date and UTC time to the nearest minute. If an adjustment is necessary because of a power outage or maintenance, enter the appropriate reason for the gap in the record.

CHART FEED-RATE ADJUSTMENTS.—

Whenever the chart feed-rate is changed, enter a time check and an appropriate note, such as "Begin 6 inches per hour" or "Begin 3 inches per hour." Chart speed rates of 1 1/2 inches per hour, 3 inches per hour, and 6 inches per hour are available by manually changing the drive gears. At the standard 3-inch-per-hour rate, a chart will last 15 days in continuous operation.

TYPE B-3 SHIPBOARD ANEMOMETER

The Type B-3 wind-measuring set falls under the cognizance of NAVSEA. It is serviced by the shipboard IC electricians, who maintain the technical manuals on the system. The only responsibility the Aerographer's Mate has in connection with this equipment is to read the indicators and to verify that the indicator is operating properly. If the indicated relative speed or direction appears to be in error, the problem is reported to the IC shop.

All ships have a minimum of two wind transmitters, located on the port and starboard yardarms. The switch used to control the transmitter in use is usually located on the bridge on smaller ships, but may be located in the geophysics office aboard aircraft carriers. Normally, the windward-side transmitter is used. The transmitters are very similar to the ML-400/UMQ-5 transmitters.

The transmitter selected reports wind direction relative to the bow of the ship and wind speed relative to the ship's motion. These winds are called relative winds. Several Type B-3 relative wind indicators (fig. 2-27) are installed throughout each ship in various locations. To convert relative wind to true wind, you must also know the ship's true heading (available from the magnetic compass [fig. 2-28] or gyroscope repeater [fig. 2-29]), as well as the ship's speed (available from the underwater-speed log indicator [fig. 2-30]). If a magnetic compass is used for the ship's course, to obtain a true heading, the magnetic declination must be added to the compass heading before that number is used in a true-wind computation. Gyro repeaters are preferable for conversion, since these readings are true headings. Both gyro repeaters and underwater-speed log indicators are usually located in the geophysics office, as well as on the bridge and at other strategic locations throughout the ship.

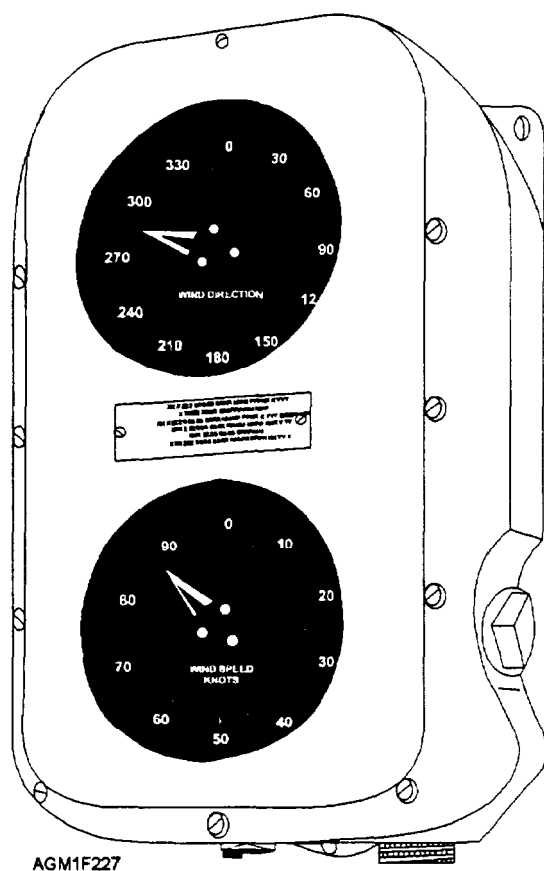


Figure 2-27.—Type B-3 shipboard relative-wind direction and relative-wind speed indicator.



Figure 2-28—Shipboard magnetic compass.

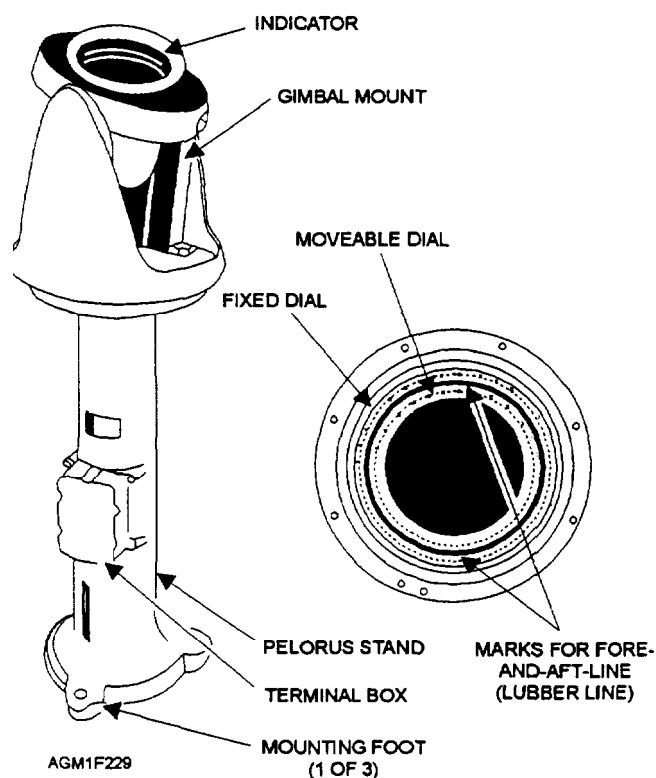


Figure 2-29.—Shipboard pelorus with a gyroscope repeater.



Figure 2-30.—Shipboard underwater-speed log indicator.

NOTE: There are two manual methods used to convert relative wind speed and direction to true wind speed and direction. The most frequently used method is the CP-264/U true-wind-computer method (see later section on the CP-264/U). The maneuvering board method is also frequently used (see DMA Pub. 217, *Maneuvering Board Manual*). The SMOOS system will automatically convert relative wind to true wind.

Since wind recorder charts are not routinely used aboard ship, the relative winds are observed directly from the wind indicator, and winds are averaged over a 2-minute period. During the appropriate observation time period, ensure that the ship's course and speed are steady. Never observe the wind while the ship is turning or changing speed. Make note of the following:

- The average relative-wind speed and direction during the period
- The peaks and lulls in the wind speed, with the appropriate direction, during the period. (Check for gust and squall criteria.)
- The degree of variability in the wind direction. (Check for variability criteria.)

True wind computations should be made for both the average wind speed and direction and the maximum gust speed and direction.

Verify computed true wind speed and direction with a check of the sea direction and sea state. Criteria for estimating wind speed from sea state are contained in Appendix V. The true wind direction is normally the same direction the seas are approaching from, particularly the smaller wavelets. If similar differences between estimated winds and computed true winds occur for several observations, a problem with the wind instruments is indicated. The following points should be reviewed when verifying true winds:

- The true wind direction is always on the same side of the ship as the apparent wind direction, but is further away from the bow (in degrees) than the apparent wind
- When the apparent wind direction is abaft the beam, the true wind speed is greater than the apparent wind speed
- When the apparent wind direction is forward of the beam, the true wind speed is less than the apparent wind speed

Whenever the shipboard anemometer is inoperative or the results are suspect, the winds should be observed by using the AN/PMQ-3 hand-held anemometer

AN/PMQ-3 HAND-HELD ANEMOMETER

The AN/PMQ-3 anemometer is found aboard ship and at many shore stations as backup wind-measuring equipment. All models of the AN/PMQ-3 are nearly identical in design and operation. Detailed guidance for operation and maintenance is found in NA 50-30PMQ3C-1, *Manual of Operation and Service Instructions for the Wind Measuring Set AN/PMQ-3(C)*. A standard AN/PMQ-3 (fig. 2-31) comes with a special storage case (not shown) in which the anemometer should be stored when not in use. The case also contains a spare wind vane and spare transmitter.

Operation

To properly use the AN/PMQ-3, you need a location with unobstructed windflow and a reference line. When ashore, a field or ramp area with a known true north reference is ideal. Aboard ship, an unobstructed area (windward side) of the flight deck or the signal bridge is acceptable. Keep as far away as possible from deck edges, since the eddy effects of wind

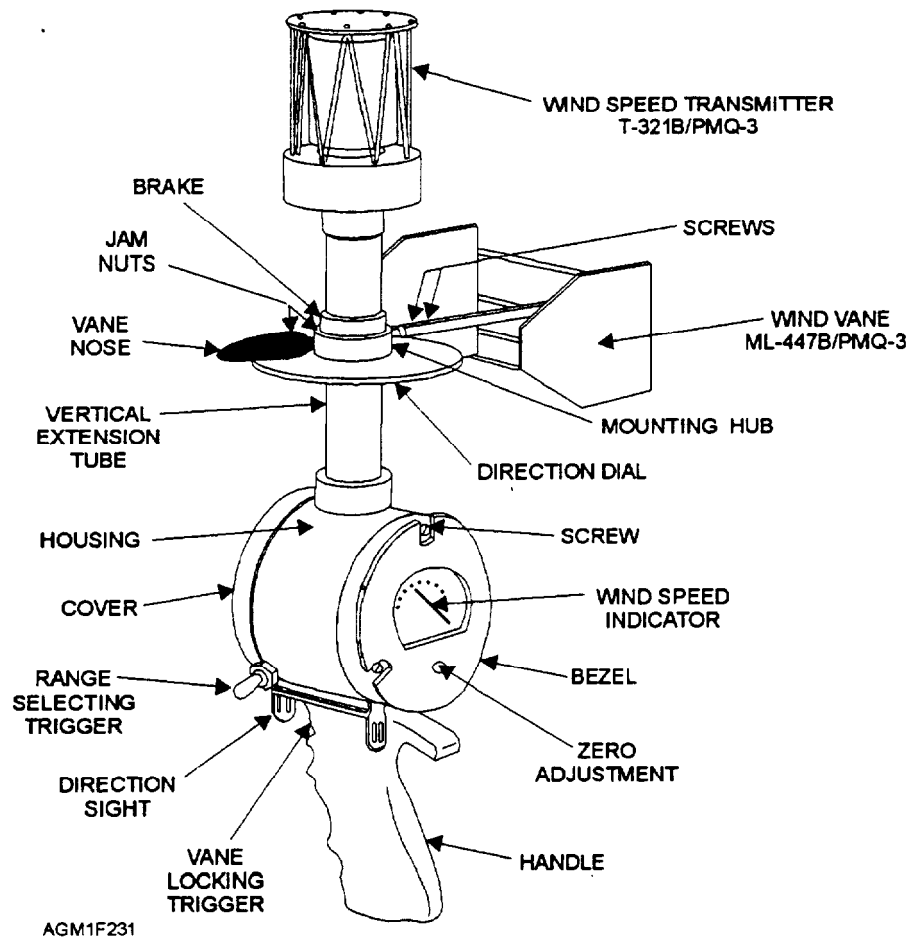


Figure 2-31.—AN/PMQ-3 hand-held anemometer.

flowing over the edge of the deck and wind combings will give inaccurate wind speed and direction. It is best to aim the sights of the AN/PMQ-3 toward the bow on a line parallel to the centerline of the ship.

Hold the instrument at arm's length and in a vertical position, with the indicator at or slightly above eye level, and align the sights with the true north reference or the bow of the ship (fig. 2-32). Depress the vane unlocking trigger to release the wind vane, and, at the same time, observe the indicated wind speed.

CAUTION

Activate the low-speed, range-selecting switch on the side of the casing on the newer models, or on the handle of the older models only if the wind speed is less than 15 knots. The indicator will be damaged if the switch is activated during higher winds.

Release the vane unlocking trigger when the wind vane yields a representative wind direction, and read the wind direction on the wind vane azimuth circle.



Figure 2-32.—Aerographer's Mate using the AN/PMQ-3 on the flight deck during flight operations. Note that hearing protection and a helmet are worn.

If a true north reference line was used at a shore station, no further computations are necessary. Aboard ship, however, you will need to obtain the ship's course and speed during the time of the observation, and compute true wind speed and direction.

Maintenance

The only recommended routine maintenance for the AN/PMQ-3 is a semiannual oiling of the wind-speed transmitter unit. Partial disassembly is required; consult the handbook for instructions. You should also wipe the instrument down with a towel dampened in freshwater to remove any salt deposits. Mild detergent may be used to remove dirt and grime.

REVIEW QUESTIONS

- Q26. *Other than automated observing systems, name three types of anemometers still used by the Navy?*
- Q27. *When should the analog recorder chart of the AN/UMQ-5 be changed?*
- Q28. *When should a time check be made on the analog recorder of the AN/UMQ-5?*
- Q29. *What type of wind measurement is made by the Type B3 wind indicator?*
- Q30. *At sea, what method should you use to verify true wind speed and direction?*
- Q31. *How does the true wind speed compare to the apparent wind speed when the apparent wind direction is forward of the beam?*
- Q32. *What procedure should you follow when using the AN/PMQ-3 at sea?*
- Q33. *When should the low-speed, range-selecting switch be activated on the AN/PMQ-3?*

RAIN GAUGES

LEARNING OBJECTIVES Describe the operation and maintenance of standard rain gauges ML-588 and ML-217.

In addition to automated observing systems, the Navy has two other standard rain gauges: the ML-588/UMQ-14 tipping-bucket rain gauge, discussed earlier as part of the AN/GMQ-29 system, and the ML-217 4-inch plastic rain gauge.

The ML-217 rain gauge (fig. 2-33) has a 4-inch funnel opening that collects and dumps precipitation into a small, graduated cylinder. The cylinder collects up to 1 inch of liquid, and measures the liquid to the nearest 1/100 of an inch. A 4-inch-diameter plastic outer casing is used to collect any overflow from the graduated cylinder. The steel support tripod that holds the rain gauge should be securely mounted on a firm, level surface.

OPERATION

The rain gauge is used to measure liquid precipitation or liquid equivalent of frozen precipitation. The amount of liquid precipitation in the graduated cylinder is read directly from the scale. A cylinder full to the brim is exactly 1 inch. After emptying, the graduated cylinder is used to measure water from the overflow cylinder.

Although it is a backup for liquid precipitation measurements, the ML-217 is the primary measuring instrument for frozen precipitation not handled by the ML-588 rain gauge or ASOS/SMOOS. When solid precipitation is expected, the collector funnel and the graduated cylinder should be removed from the 4-inch overflow cylinder to allow the frozen precipitation to accumulate directly into the overflow cylinder. The

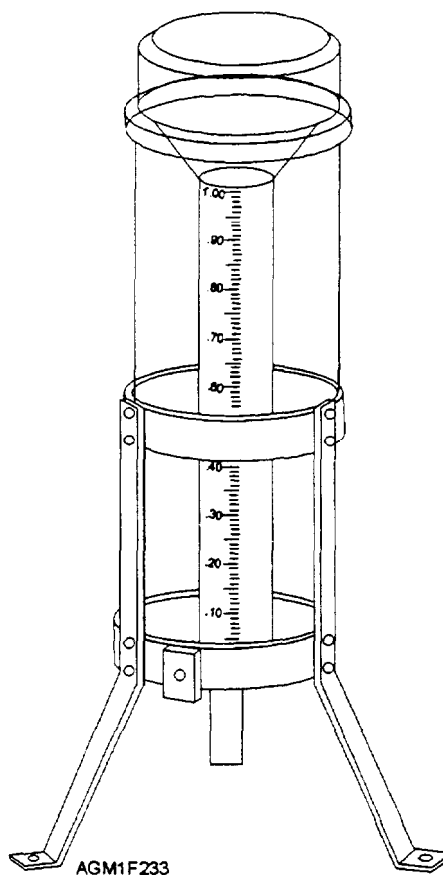


Figure 2-33.—ML-217 4-inch plastic rain gauge.

melted precipitation is measured to determine liquid equivalent. The overflow cylinder may also be used to take a core sample of accumulated frozen precipitation. When the sample is melted, it is measured in the graduated cylinder to obtain liquid equivalent.

MAINTENANCE

The primary maintenance action for the ML-217 rain gauge is keeping the gauge clean. Water and, if necessary, mild detergent may be used to clean the plastic parts. The steel support tripod will need periodic rust removal and repainting.

REVIEW QUESTIONS

- Q34. How much precipitation can the graduated cylinder of the 1-inch rain gauge hold?*
- Q35. Which rain gauge is used primarily for the measurement of frozen precipitation?*

AN/GMQ-32 TRANSMISSOMETER

LEARNING OBJECTIVES: Define transmissometer. Describe the operation and maintenance of the major components of the AN/GMQ-32 system. Explain the required AN/GMQ-32 recorder chart notations. Describe the operation and maintenance of the OA-7900/GMQ-10 converter/indicator group.

A transmissometer is an instrument that measures how well light travels through a substance. In meteorology, a transmissometer is a device used to measure the transmissivity of light through air to determine visibility. In addition to the visual-range sensor on the ASOS, there is one system used by Naval and Marine Corps shore activities—the AN/GMQ-32 transmissometer system (formerly called the AN/GMQ-10).

The AN/GMQ-32 transmissometer provides a visual and graphic record of the transmissivity of light between the projector and the detector. This charted value, with some standard adjustments, may be converted to sector visibility or to runway visual range. *Sector visibility* is how far an unlighted object can be seen during the day, while *runway visual range (RVR)* is how far the runway lights can be seen by a pilot. Without any change in weather conditions, the runway visual range may be increased by simply turning up the intensity of the runway lighting.

MAJOR COMPONENTS

The AN/GMQ-32 transmissometer system (fig. 2-34) consists of one or more sets of ML-461/GMQ-10 transmissometer projectors and R-547/GMQ-10 receivers, located on the airfield; their associated electrical equipment and cables; and either the ID-353B/GMQ-10 or the ID-820/GMQ-10 transmissometer indicator/recorder unit. A separate equipment system, used with most AN/GMQ-32

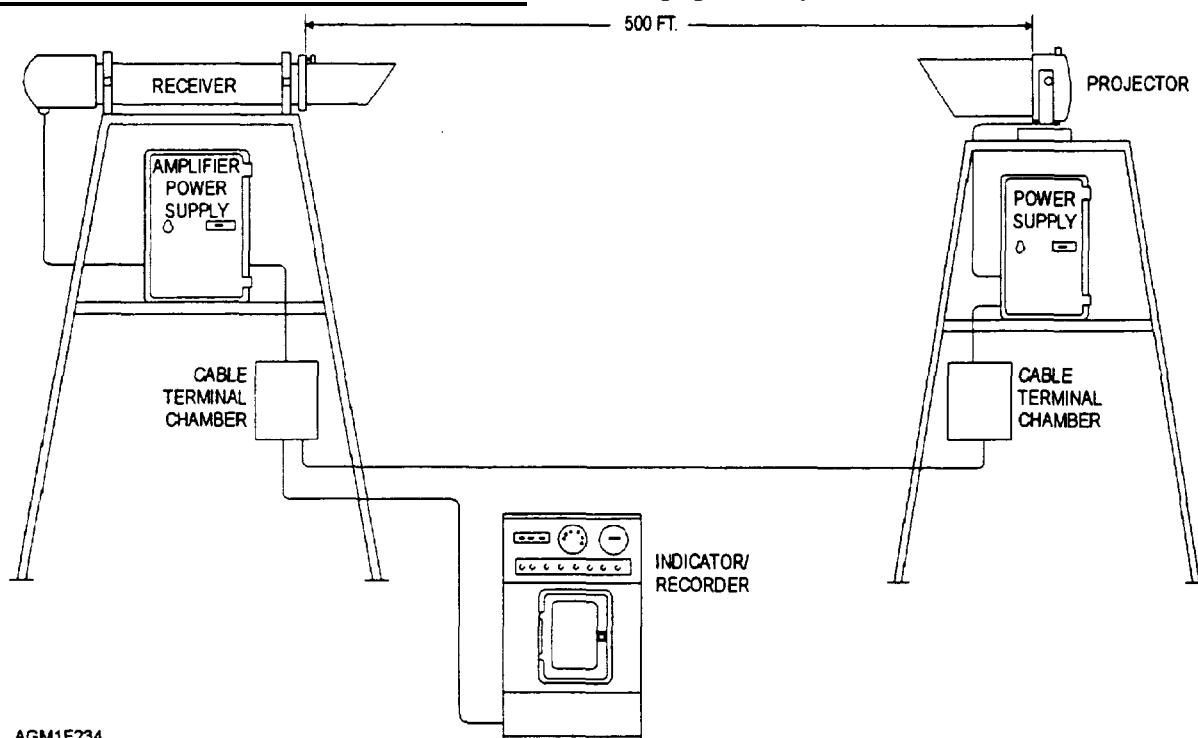


Figure 2-34.—AN/GMQ-32 transmissometer equipment installation.

installations, is the OA-7900/GMQ-10 converter/indicator group. It provides a LED digital display of runway visual range in hundreds of feet.

The AN/GMQ-32 system is an upgrade of the AN/GMQ-10 system. This major change replaced the vacuum-tube electronics of the AN/GMQ-10 with solid-state circuitry. The external appearance of the equipment was not changed. The equipment still retains the original identification plates.

INDICATOR/RECORDER UNIT

The ID-353B/GMQ-10(B) or the ID-820/GMQ-10(C) transmissometer indicator/recorder unit (fig. 2-35) is found in the observer's work area of Naval Meteorology and Oceanography detachments and Marine Corps weather offices. The only visible difference between the two models is that the calibration setting meter is found only on the ID-353B, which was originally designed for use overseas where the local electricity did not conform to the carefully maintained 60-hertz AC found in the United States.

Operation

The transmissometer equipment is normally left on. It is turned off only for maintenance. If the system has been turned off, start-up calibration adjustments are required after a 1-hour warm-up period.

Detailed operational procedures for the upgraded AN/GMQ-32 system, including the ID-353/GMQ-10 and ID-820/GMQ-10 transmissometer indicator/recorder, are found in Air Force Technical Order (AFTO) 31M1-2 GMQ-32-1, *Operation Manual, Transmissometer AN/GMQ-32*, provided with each equipment modification. Instructions provided in NAVWEPS 50-30GMQ-10-2, *Technical Manual, Operation and Maintenance Instructions with Illustrated Parts Breakdown*, for the mechanical components, such as the spring chart drive, are still valid and may be used if the AFTO is not available. Instructions and criteria for use of transmissometer data are contained in NAVMETOCCOMINST 3141.2.

The transmissometer indicator/recorder provides two output readings: the recorder graph and the transmissivity meter. Both outputs provide transmissivity percentages. Two sensitivity settings are used to process incoming data. The indicator/recorder is normally operated in the LOW sensitivity setting, but the HIGH sensitivity setting may be used during low-visibility conditions, when transmissivity falls below 20%. The HIGH setting simply multiplies the

indicator/recorder output by 5, which allows the operator to read the output more accurately. Both readings must be corrected for background illumination and converted by using the tables provided in NAVMETOCCOMINST 3141.2 to yield runway visual range or sector visibility.

The background illumination correction is found by placing the Background switch in the TEST position, obtaining a background illumination level, and then subtracting the background illumination level from the transmissivity reading to obtain a corrected transmissivity reading.

The runway visual range (RVR) table in NAVMETOCCOMINST 3141.2 is in two sections: one for use during the day and the other for use at night. Columns are provided for runway light settings (LS) 5, 4, 3, and Other. The Other column is used when runway lighting is either not in operation or at setting 1 or 2. The runway light setting is obtained from the air traffic controllers. Use the transmissivity value in the proper light setting column to find RVR.

Maintenance

General maintenance for the AN/GMQ-32 system is performed by base ground electronics personnel or trained METEM (METeorological Equipment Maintenance) Electronics Technicians. Refer to the care-and-use publications for more detailed information. The following routine maintenance is usually performed by the observer:

- Replacing the recorder paper—Replace the paper by using the reloading diagram exposed in the recorder window. Charts in continuous operation run at 3 inches per hour and are normally changed every 2 weeks
- Rewinding the recorder chart drive spring—Rewind when setting the recorder chart time or once per week. A fully wound drive will operate for 8 days
- Adjusting the recorder zero adjustment—Adjust daily when the recorder is in use
- Refilling/cleaning the inkwell and pens—Empty and clean inkwells, indicator pens, and marker pens once a month. In many recorders, the inkwells have been removed and pen cartridges have replaced the ink pens

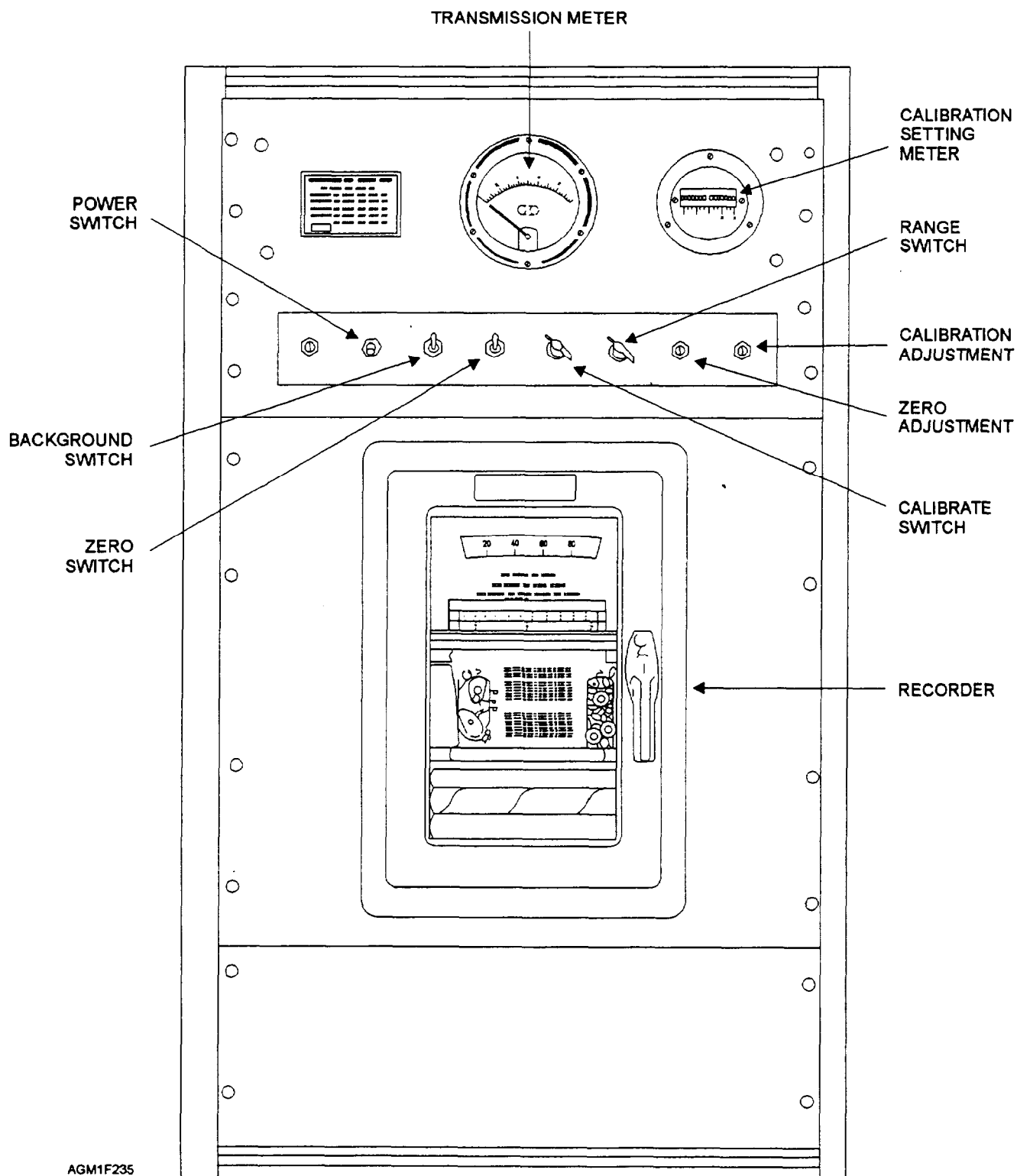


Figure 2-35.—ID-353B/GMQ-10(B) or ID-820/GMQ-10(C) transmissometer indicator/recorder.

Required AN/GMQ-32 Recorder Chart Notations

Transmissometer recorder charts (fig. 2-36) should be set to Coordinated Universal Time (UTC); they must have a time check with a date-time group entered at the following times:

- The beginning and end of each roll
- The actual time of each synoptic hour observation
- The beginning and ending of maintenance shutdowns or other periods when the recorder is not in service
- When you are notified of any aircraft mishap at or near your station

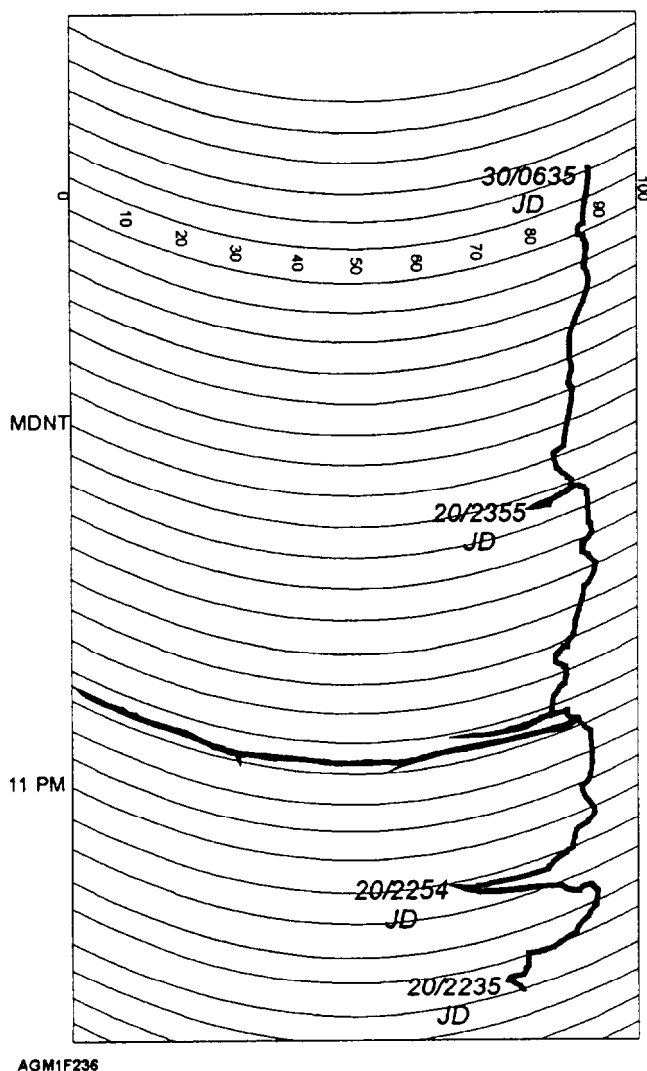


Figure 2-36.—AN/GMQ-32 transmissometer recorder chart notations.

In addition to the regular time checks with a date-time group, other notations are required on the recorder chart on the following occasions:

- When the chart time differs by more than 5 minutes from the actual time. (Place a date-time group on the position the pen was recording on the chart, correct the chart time position, and enter a new date-time group on the adjusted position.)
- When a chart or any portion of the chart is provided for any special study or investigation. (Enter the station name, runway number, length of the baseline, and month and year on the chart, in addition to the required time checks.)

OA-7900A/GMQ-10 CONVERTER/INDICATOR GROUP

The OA-7900A/GMQ-10 converter/indicator group, consisting of an ID-1939/GMQ-10 digital LED visibility indicator and a CV-3125/GMQ-10 signal converter (fig. 2-37), was added to most AN/GMQ-10 systems in the early 1970's. The original ID-1939 visibility indicators used an electromechanical display dial that was very difficult to maintain and suffered a great deal of downtime. The display dials were removed in the mid-1970's and replaced with programmable-read-only-memory (PROM) computer chips and an LED readout for runway visual range (RVR), in hundreds of feet.

Operation

The OA7900/GMQ-10 will provide readouts for two different visibility readings. It provides sector visibility, in the vicinity of the runway, and runway visual range. Operating the OA7900/GMQ-10 in NORMAL mode yields sector visibility. Operating the converter in DAY or NIGHT mode, and setting the Light-setting switch to the indicated runway-lighting intensity, activates different calculations in the memory to yield runway visual range. No correction for background illumination is required. Check with the air traffic controllers to verify the runway light-intensity setting. Runway lights are frequently operated at setting 2 or 3, but a pilot may request that the level (setting) be changed. Level 1 is dimmest and 5 brightest. Ideally, the setting used is the lowest setting that lights can be seen through any obstruction to visibility. Study the operator's manual NA 50-30GMQ10-7, *Operator and Maintenance Instructions with Illustrated Parts Breakdown, OA-7900A/GMQ-10*, for further details on operating and maintaining this system.

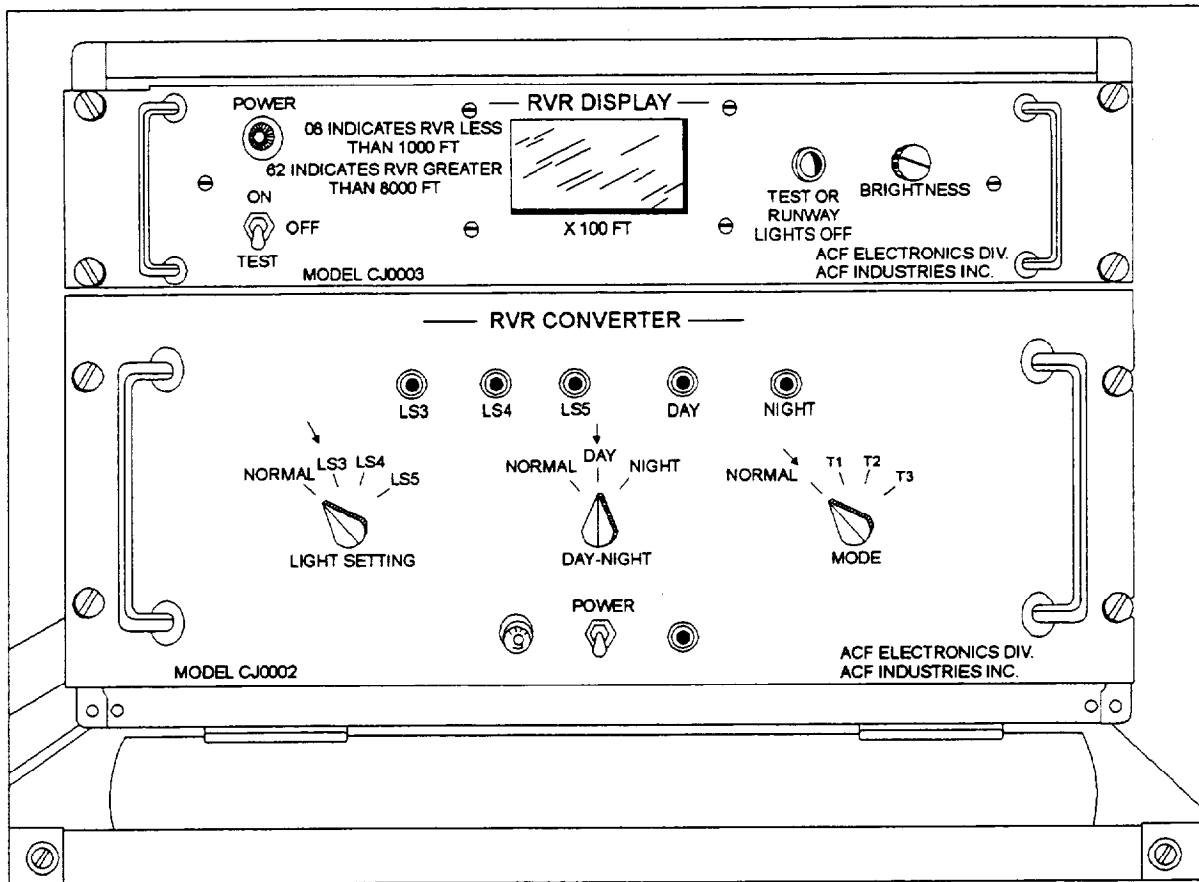


Figure 2-37.—OA-7900A/GMQ-10 Converter/Indicator Group consisting of the ID-1939/GMQ-10 digital LED indicator and the CV-3125/GMQ-10 signal converter.

Maintenance

This equipment requires very little operator maintenance. Maintenance includes cleaning the fan screen on the rear of the converter and keeping external surfaces clean. Refer to the operator's manual for details.

REVIEW QUESTIONS

- Q36. What does a meteorological transmissometer actually measure?
- Q37. How do the terms "sector visibility" and "runway visual range" differ with respect to the AN/GMQ-32?
- Q38. What publication contains criteria and instructions for the use of transmissometers?
- Q39. How are transmissivity values presented on the AN/GMQ-32 and how are these values converted?
- Q40. What routine maintenance is normally accomplished by the observer with respect to the AN/GMQ-32?

CLOUD HEIGHT EQUIPMENT

LEARNING OBJECTIVES: Describe the operation, recorder trace outputs, and maintenance of the AN/GMQ-13 cloud height set. Explain the operation and maintenance of the ML-121 ceiling height projector and clinometers used ashore and at sea. Describe two types of ceiling balloons, how they are inflated, and how they are used to determine cloud height.

In this section we will discuss some of the more frequently used types of cloud-height measuring equipment. The AN/GMQ-13 cloud height set (also called the rotating beam ceilometer or RBC), is still the primary cloud-height measuring equipment in use at some shore stations. The AN/GMQ-13 is currently being replaced by the ASOS cloud height detector. Most shore stations also have backup cloud-height measuring equipment, which consists of an ML-121 ceiling light projector and ML-119 clinometer. Aboard ship, an ML-591/U shipboard clinometer is used in

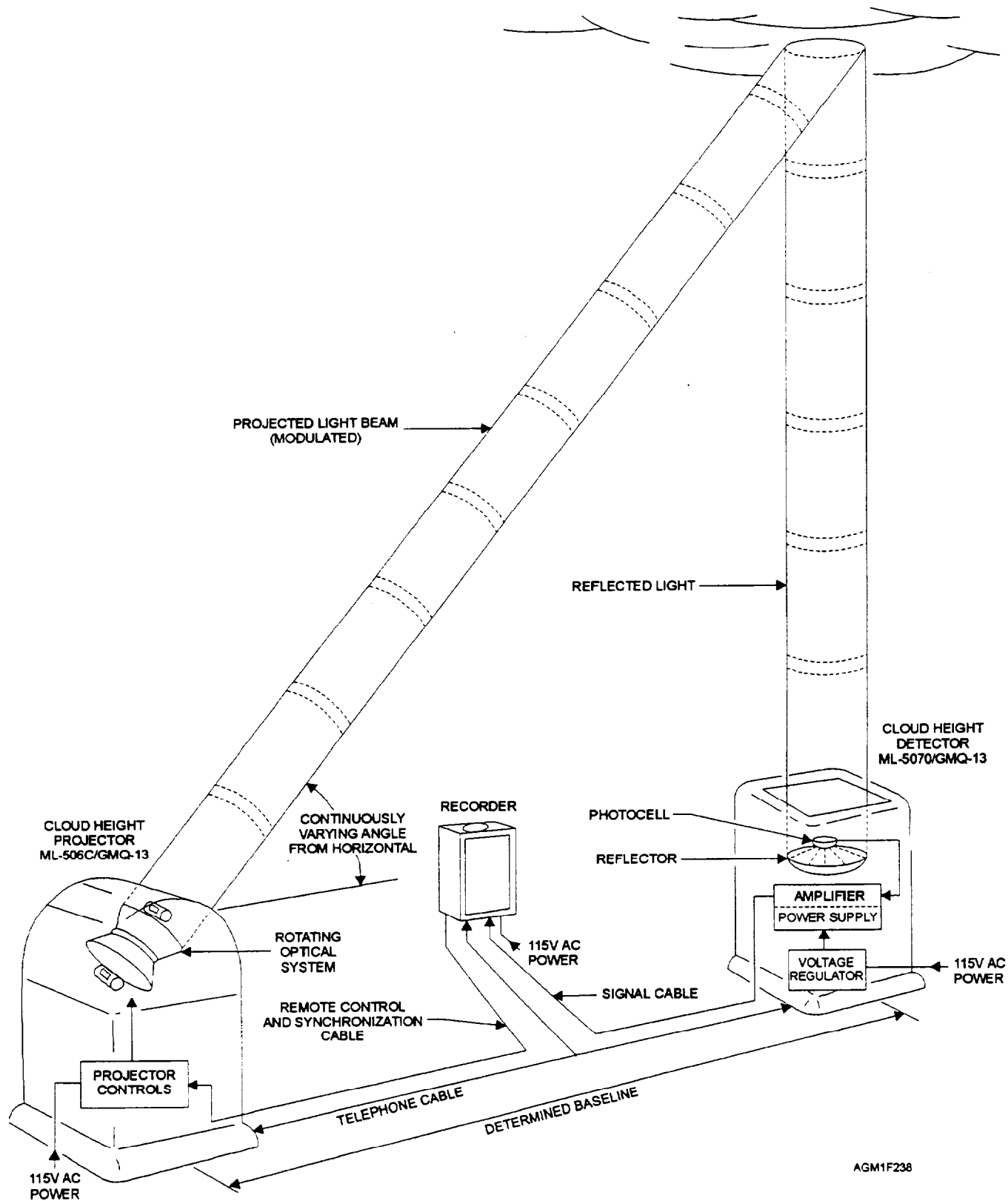


Figure 2-38.—ML-506/GMQ-13 RBC projector and ML-507/GMQ-13 cloud height detector setup.

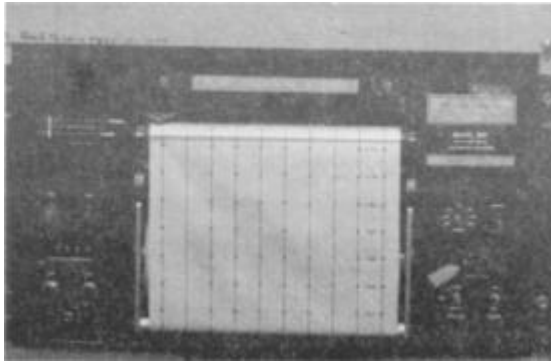


Figure 2-39.—RO-546/GMQ-13 GIFFT cloud height recorder.

conjunction with the ML-121 ceiling light projector. Ceiling balloons may also be used to determine cloud height, both ashore and at sea.

AN/GMQ-13 CLOUD HEIGHT SET

The AN/GMQ-13 cloud height set was introduced to the fleet from 1955 to 1959. Over the years many modifications have been made to the individual pieces of equipment. Currently, the cloud height set consists of an ML-506/GMQ-13 rotating beam projector, an ML-507/GMQ-13 cloud height detector, and an RO-546/GMQ-13 GIFFT ceiling height recorder. The projector and the detector are permanently installed near the main runway, but are separated by a 400- to 900-foot baseline. See figure 2-38 for a standard setup diagram. The standard baseline is 400 feet. Cloud height is determined by the angle of the projected light beam reflected from the base of the clouds directly overhead the receiver. The GIFFT cloud height recorder, usually rack-mounted in the observer's space (fig. 2-39), records angle-of-reflection on a chart.

Operation

Detailed information on the theory of operation, operating instructions, and maintenance guidance for the projector and receiver is contained in NA 50-30GMQ13-1, *Handbook, Operation and Service Instructions, with Illustrated Parts Breakdown, Cloud Height Set AN/GMQ-13(C)*. Operation and maintenance guidance for the RO-546/GMQ-13 GIFFT recorder is published in the manufacturer's instructions provided with the equipment.

Evaluation of the Recorder Trace

The RO-546 recorder chart is marked in hours and tens of minutes. The time marking "234" equates to 2340Z. Time adjustments are covered in the operator's manual.

The procedure used to determine cloud height using the GIFFT recorder has been refined since the manufacturer provided the operator's manual. The recorder elevation angle is evaluated differently for various weather conditions. In some cases, the indicated elevation angle must be corrected to obtain an accurate cloud-base height.

CORRECTION FACTOR.—An equipment correction must be determined for each individual GIFFT recorder before any recorded elevation angles may be used to determine cloud height. The following procedure is used for RO-546 recorders when the ML-506 RBC projector and ML-507 RBC receiver are separated by the standard, 400-foot, baseline.

To obtain the equipment correction, make a recording of a high, solid cloud cover with bases between 10,000 and 20,000 feet. This solid cloud cover should produce a fairly consistent solid band, 4° to 8° wide, on the recorder chart. Solid, well-defined cloud bases will produce a shorter trace, while diffuse or ragged bases will produce a longer trace. See figure 2-40. The occasional horizontal lines marked outside

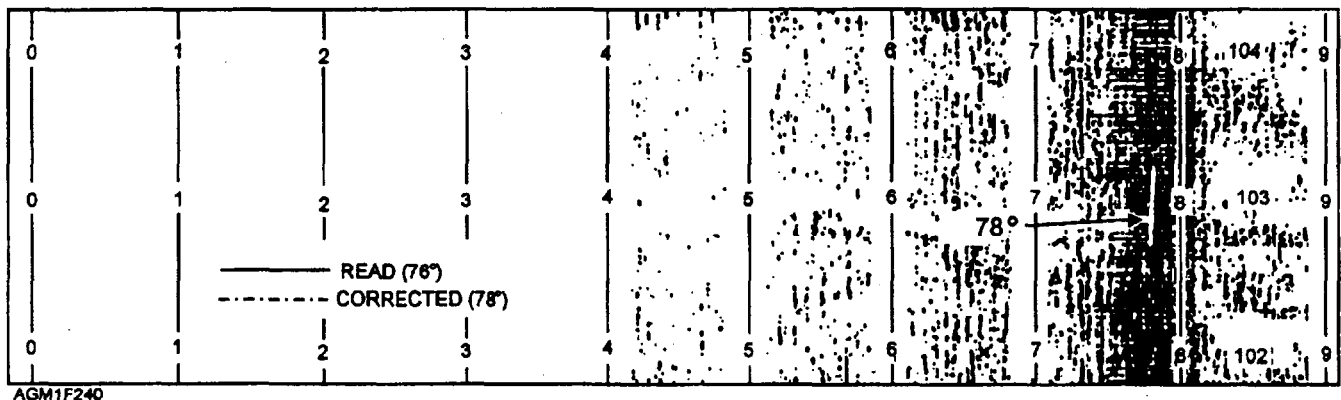


Figure 2-40.—Determining equipment correction from high, solid cloud cover.

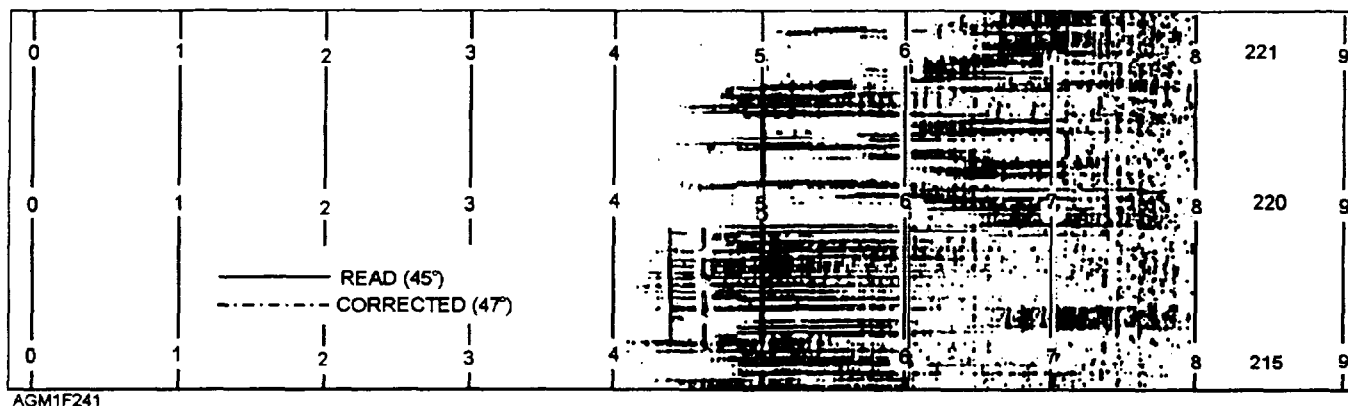


Figure 2-41.—Determining corrected cloud elevation angle with multiple cloud layers.

the band are ignored. The width of the solid band, in degrees, divided by 2 is the equipment correction for the recorder. The correction factor is applied to recorded elevation angles for all solid cloud bases and diffuse stratus bases over 45° elevation.

The length of the thin marking lines is an indication of the reflected light sensed by the receiver. Line length is affected by the focus and output candlepower of each of the two lights in the RBC projector. Replacing the bulbs in the projector, cleaning a dirty projector lens, or refocusing the projector lights will change the characteristic length of the recorder marking lines; and a change in line length will require that anew equipment correction be determined.

SOLID CLOUD COVER.—The cloud elevation angle of solid cloud cover, such as is indicated in figure 2-40, is read at the left edge of the solid band. The equipment correction, 2° in this case, is then added to the indicated elevation angle to find the corrected

elevation angle. For solid cloud cover only, the corrected elevation angle is the same as reading the elevation angle at the center of the solid band.

MULTIPLE CLOUD LAYERS.—Read the angle at the left side of the solid band, and then add the correction to obtain the proper cloud angle. For example, in figure 2-41, at time 2154Z, the solid line at 45° elevation was drawn for the left side of the solid portion of the band. The equipment correction, 2° , found from figure 2-40, is added to find the corrected angle of the cloud bases, 47° .

FOG AND LOW STRATUS.—Read the elevation angle at the left side of the solid band. Do not add the correction unless the correction yields an elevation angle greater than or equal to 45° . Figure 2-42 shows a low-stratus situation that became fog on the deck at time mark 000. Between 2320Z and 2330Z, the stratus shows a solid band at 44° . Adding the equipment correction results in a corrected elevation angle of 46° ,

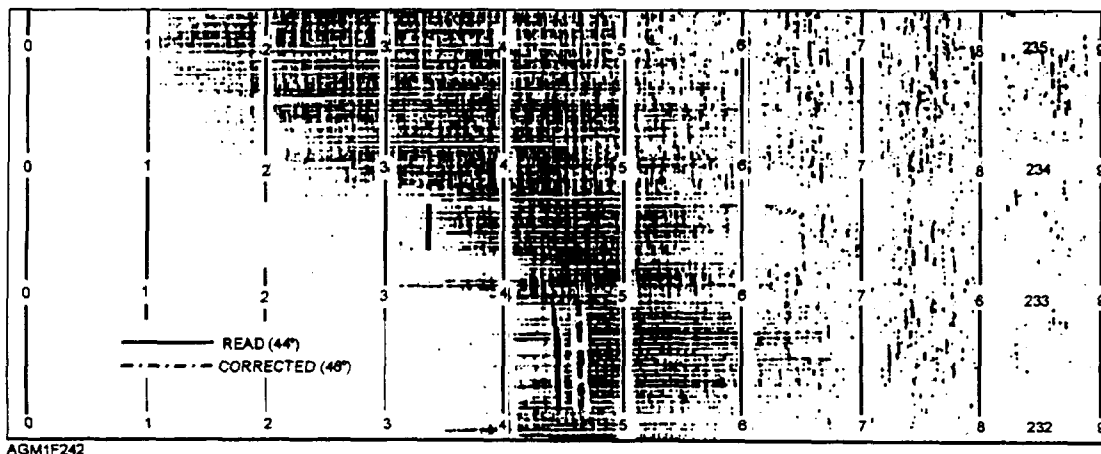


Figure 2-42.—Determining cloud elevation angles for low stratus and fog.

so adding the correction is acceptable. At 2334Z, we read the left side of the solid band at 33°. Adding the equipment correction of 2° would result in only a 35° corrected angle. Since the correction is less than 45°, the correction is not added, and the 33° elevation angle should be used.

CONVERTING ELEVATION ANGLE TO CLOUD HEIGHT.—The operator's manual for the GIFFT recorder contains a table for converting elevation angle to cloud height for units using the standard 400-foot baseline. A table may be constructed for your unit's baseline, if different from the standard, by multiplying the tangent of the elevation angles from 1° through 89° by the length of your baseline, in feet.

Maintenance

Maintenance requirements for the RO-546 recorder are described in the operator's manual. All calibrations and electrical checks are performed by base ground electronics personnel. Aerographer's Mates are responsible for changing the recorder chart paper and replacing the chart-marking stylus when the old stylus becomes worn, broken, or bent. Pilot-reported cloud heights that are consistently different from RO-546 indicated heights, or other indications of malfunction, should be reported to ground electronics. Backup equipment, such as the ML-121 ceiling light projector and the ML-119 clinometer, should be used when the AN/GMQ-13 is out of service.

ML-121 CEILING LIGHT PROJECTOR

The standard light projector used by the Navy and Marine Corps is the ML-121 ceiling light projector, shown in figure 2-43. This equipment projects a narrow, concentrated beam of light vertically onto cloud bases up to 10,000 feet. An observer, sighting at the illuminated spot on a cloud base, uses clinometer elevation angle and baseline distance to find cloud height. The light projector is effective only at night.

Operation

The ceiling light projector is activated by a switch located in the weather office or outside near the observation point. The projector must be activated only when conducting a measurement. The high-intensity light may confuse pilots, both ashore and aboard ship; therefore, you must request permission from your supervisor to activate the projector.

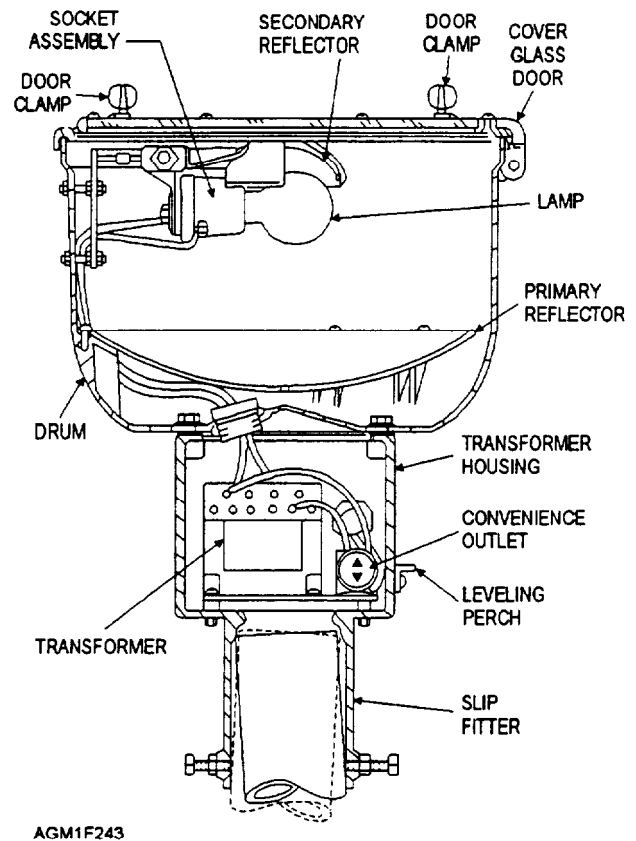


Figure 2-43.—ML-121 ceiling light projector.

Maintenance

Ground electronics personnel should provide maintenance support for the projector. Maintenance procedures are described in NA 50-30FR-521, *Handbook, Operation and Maintenance Instructions, Ceiling Light Projector ML-121 and Clinometer ML-119*. Recommended operator maintenance includes the following:

- Weekly cleaning of glass cover plate and inspection and cleaning of drainage/ventilation holes in the projector housing
- Replacing lamps that are burned out or have blackened or sagging filaments
- Quarterly checking of lamp alignment and focus, and inspecting the projector to make sure it is level

CLINOMETER

Clinometers are used to measure the elevation angle of the projected light spot on a cloud base. Two different types of clinometers are used: the ML-119 clinometer, found only at shore stations, and the ML-591/U

shipboard clinometer, used both aboard ship and ashore. The ML-119 clinometer is shown in figure 2-44. It is hand-held, whereas the shipboard clinometer is mounted on a bracket and supplied with a weatherproof cover; operation is similar.

Operation

To operate the clinometer, loosen the clutch screw to allow the elevation scale to swing freely. After sighting the light spot on the cloud base, bring the cross hairs to bear on the spot. Then, with the cross hairs on the spot, tighten the clutch screw, and read the elevation angle from the scale to the nearest whole degree. Cloud height is calculated by multiplying the baseline distance by the tangent of the elevation angle. Normally, a minimum of three readings are used to determine an average. Aboard ship, add the height of the clinometer above the waterline to the calculated distance. Where established premeasured baselines are used, tables for converting measured elevation angle to cloud height may have been previously calculated and may be available. NAVMETOCCOMINST 3144.1 provides

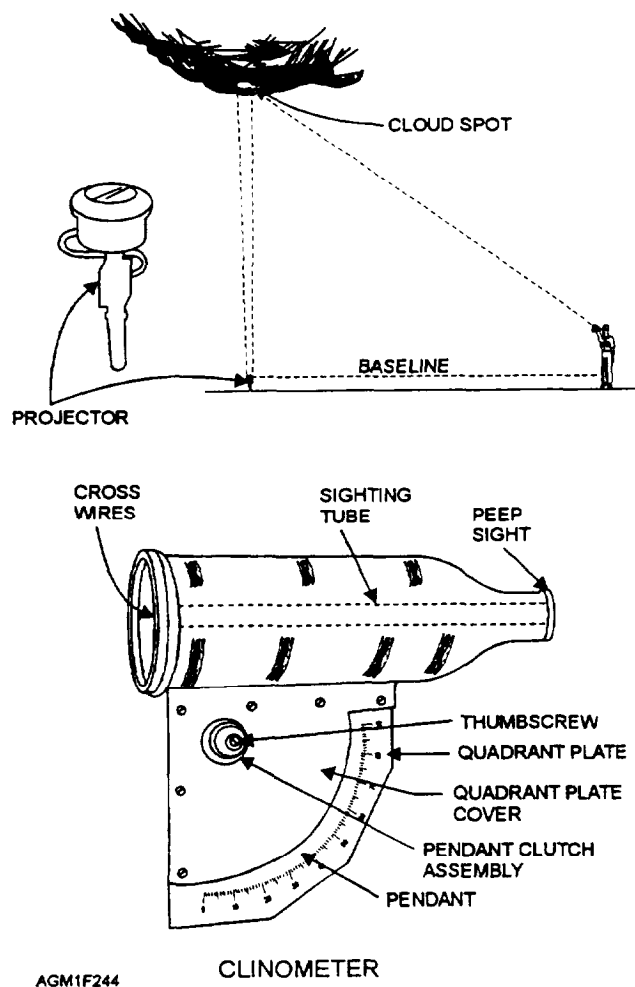


Figure 2-44.—ML-119 clinometer.

summarized procedures for using the shipboard clinometer.

Maintenance

Maintenance procedures for the ML-119 clinometer are described in NA 50-30FR-521 and for the ML-591/U clinometer in NAVWEPS 50-30FR13, *Technical Manual, Operation, Maintenance, and Overhaul Instructions with Illustrated Parts Breakdown, (Shipboard) Elevator Clinometer ML-591/U*. Monthly cleaning is recommended, along with inspection to make sure the parts move freely. Aerographer's Mates are normally responsible for all maintenance on clinometers.

CEILING BALLOONS

Ceiling balloon measurements are still a valid procedure to determine cloud height when other methods fail. Although not routinely accomplished at most Naval meteorology and oceanography detachments, ceiling balloon observations are common aboard ship and at most Marine Corps weather stations. Ceiling balloons are primarily used as a backup method to determine cloud height during the day when ceiling lights cannot be used.

Ceiling balloons provide a reasonable height determination up to 2,000 feet. Since heavy precipitation will slow the ascension rate enough to invalidate any measurement, avoid balloon measurement during such conditions.

The equipment required for a ceiling balloon observation includes the balloons, balloon weight set, a stopwatch, helium, and a helium regulator with a balloon-inflation nozzle. In this section we discuss the balloons, the balloon-inflation procedure with the weight set, and the method used to determine cloud or ceiling height.

Balloon Types

Several different sizes and colors of balloons may be used for ceiling determination. The balloons are available in both red and black; the red balloons are used for thin cloud cover or on hazy days, while the black balloons are used for all other cloud conditions. Although the standard ceiling balloons are the 10-gram balloons, 30-gram balloons provide a faster ascension rate and are preferable for use during high-wind conditions. Use of the slower ascending, 10-gram balloon during high winds may result in the balloon being carried out of sight horizontally before it reaches the cloud layer or ceiling.

Balloon Inflation

Balloons should be inflated slowly, with helium. A 10-gram balloon should take 3/4 to 1 minute to fill, and a 30-gram balloon should take 2 1/2 to 3 minutes to fill. This slow inflation rate allows the balloons to stretch properly during filling.

The balloons are inflated by using the ML-575/UM universal balloon balance set (fig. 2-45). Refer to the technical data supplied with the set for detailed information. The 10-gram balloons, attached to the inflation nozzle weighted to 45 grams, are inflated to neutral buoyancy. This yields 45-grams of free lift. The 30-gram balloons are inflated to 139-gram free lift. Chemical lights and balloon-tying cords are added to the inflation nozzle during inflation, but are not calculated in the weighting figures.

Determination of Cloud Height

You must always request permission from the Officer of the Deck (OOD) and the Air Boss aboard a carrier, or from the air traffic controller at an air station, to release a ceiling balloon. After clearance is received, the ceiling balloon is released and the ascension is timed. Cloud height is determined by the elapsed time, in minutes and seconds, that the balloon takes to enter into the cloud base. Consider the point of entry as midway between the time the balloon first begins to fade and the time of complete disappearance for layers aloft. Use the point at which the balloon disappears to estimate vertical visibility. Use the standard ascension rate tables in either NAVMETOCCOMINST 3141.2 or NAVMETOCCOMINST 3144.1 to determine the height.

So far, we have covered most of the equipment used in surface aviation weather observations. We have mentioned a few of the calculators used to compute

observational data, such as the psychrometric computer and the true wind computer. Now let's discuss the various types of calculators used in surface observations.

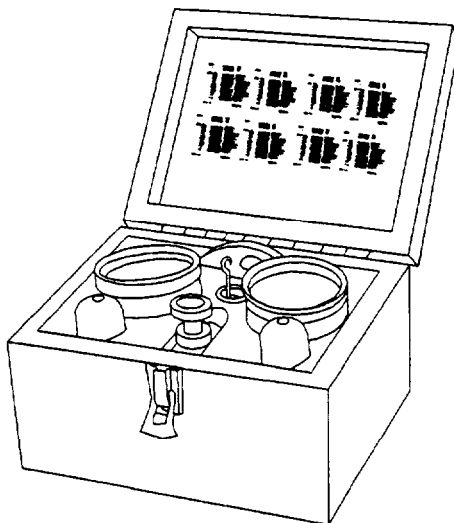
REVIEW QUESTIONS

- Q41. *What are the three main parts of the ML-507/GMQ-13 Cloud Height Set?*
- Q42. *When you use the ML-507/GMQ-13, how are cloud heights determined?*
- Q43. *What data must be computed for each individual RO-546/GMQ-13 GIFFT recorder?*
- Q44. *When is the correction factor of the GIFFT recorder not applied?*
- Q45. *What instrument is used in conjunction with the ML-121 Ceiling Light Projector to obtain cloud heights?*
- Q46. *What publication contains instructions for using the shipboard clinometer?*
- Q47. *How are cloud heights determined when using a clinometer?*
- Q48. *Under what conditions should red ceiling balloons be used to measure cloud heights?*
- Q49. *Why should larger, 30-gram balloons be used in high wind conditions vice 10-gram balloons?*
- Q50. *How is cloud height determined when you use ceiling balloons?*

CALCULATORS

LEARNING OBJECTIVE: Explain the care and use of four types of hand-held calculators.

In the 1930's and 1940's, the military first made serious attempts to study the weather and apply it operationally. Much of the data, such as dew-point temperature and relative humidity, had to be determined from printed tables (such as those available in the *Smithsonian Meteorological Tables*) or calculated manually. In the ensuing decades, as meteorology became more of a precise science, many paper nomograms and metal or plastic calculators were developed to make the calculations easier. These nomograms and calculators helped free the user from bulky printed tables. Although the built-in computational power of the ASOS and SMOOS perform many of these calculations, we include this section on the proper use and care of the most frequently



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Figure 2-45.—ML-575/UM universal balloon balance set.

used calculators, because they will continue to be used as backup equipment. The calculators used for computations of surface observational data are the pressure reduction computer, the psychrometric computer, the density altitude computer, and the true wind computer.

Proper care of all plastic and metal calculators is important to keeping these devices functional. The plastic and metal surfaces should be kept free of any sand or abrasive particles. Clean the space between adjacent plastic or metal disks by drawing a piece of blotter paper through the space. Wash the calculator in freshwater, using a mild detergent if necessary. Dry the calculator thoroughly. Use ordinary desk blotter paper to dry the space between disks. Do not use solvents to clean calculators; solvents will dissolve or soften the plastic.

Store plastic and metal calculators in a cool, dry location. If the storage temperature exceeds 140°F, the

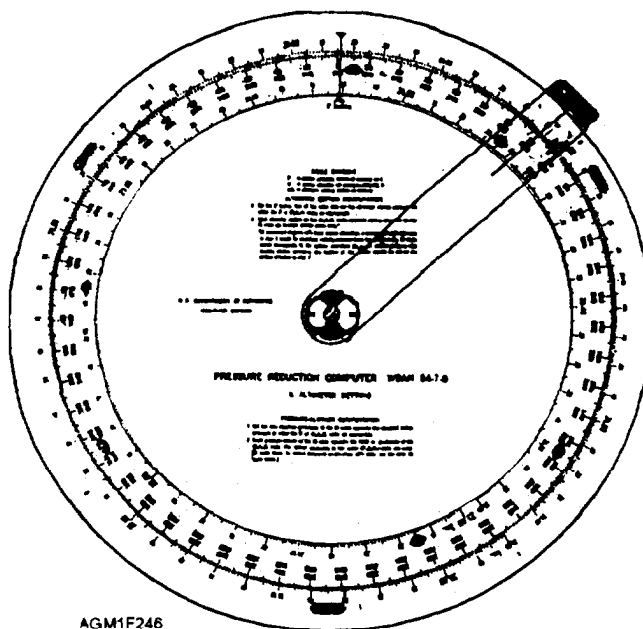


Figure 2-46.—CP-402/UM pressure reduction computer.

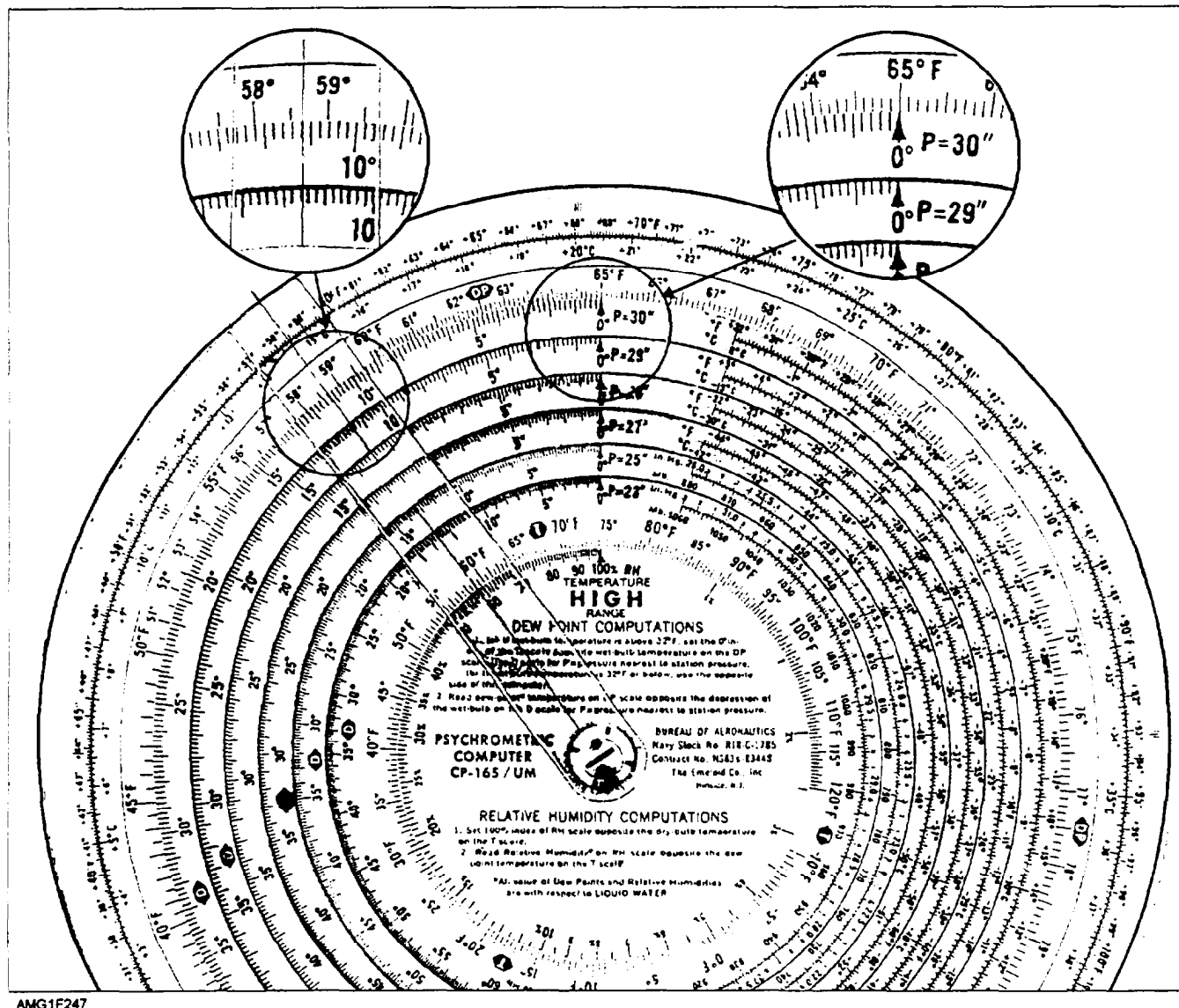


Figure 2-47.—CP-165/UM psychrometric computer.

plastic parts will warp, melt, or shrink. Aboard ship, stow plastic calculators in an accessible but secure place. The shock of falling off a plotting table or desktop in high seas may crack the plastic disks.

CP-402/UM PRESSURE REDUCTION COMPUTER

The CP-402/UM pressure reduction computer (fig. 2-46) is a two-sided calculator used to compute sea-level pressure, altimeter setting, and pressure altitude from station pressure. Detailed instructions for each process are printed on the calculator.

CP-165/UM PSYCHROMETRIC COMPUTER

The CP-165/UM psychrometric computer (fig. 2-47) is a very colorful, two-sided calculator used to

compute dew-point temperature from air temperature, wet-bulb temperature, and pressure. One side is used when the air temperature is above freezing (32°F), while the other side is used for computations when the temperature is at or below freezing. The psychrometric computer may also be used to calculate relative humidity from air and dew-point temperature, and to convert between the Fahrenheit and Celsius scales. Detailed instructions for use are printed on the calculator and are also published in NA 50-30FR-523, *Handbook, Operation and Care of Aerological Calculators, Computers, and Evaluators*.

CP-718/UM DENSITY ALTITUDE COMPUTER

The CP-718/UM density altitude computer is shown in figure 2-48. It is primarily used to compute

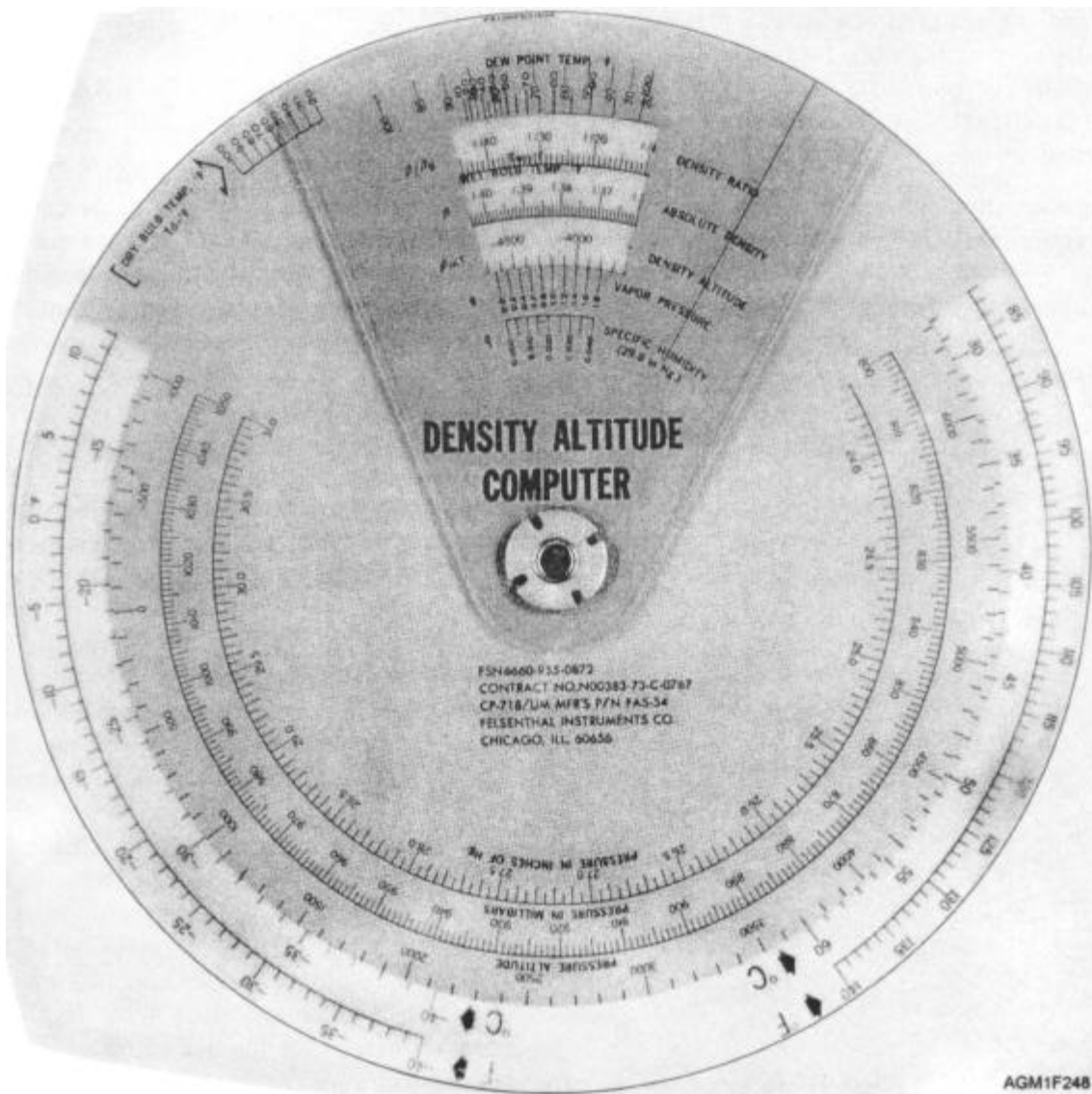


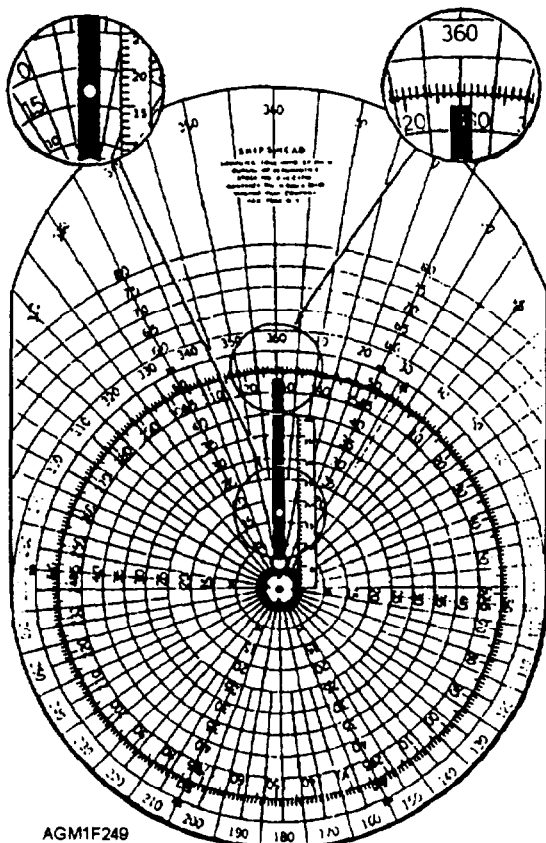
Figure 2-48.—CP-718/UM density altitude computer.

pressure altitude from pressure and air temperature, and to compute density altitude using the pressure, air temperature, and dew-point temperature. It may also be used to compute density ratio, absolute density, vapor pressure, and specific humidity. Detailed instructions for the computation of pressure altitude and density altitude are printed on the back of the calculator.

CP-264/U TRUE WIND COMPUTER

The CP-264/U true wind computer (fig. 2-49) is used to convert relative wind direction and speed to true wind direction and speed, using the ship's heading and speed. It may also be used to compute ship's course and speed, necessary to obtain a relative wind direction and speed across the deck for aircraft operations. The inputs for this calculation are the actual (true) wind speed and direction, and the required relative wind speed and direction. Detailed instructions for use are printed on the back of the computer and in NA 50-30FR-523. NAVMETOCCOMINST 3144.1 also contains information on the use of the CP-264/U calculator.

Throughout this chapter we have discussed "backup" equipment for primary-use observation equipment. You will occasionally need to use the backup equipment when your primary equipment fails.



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Figure 2-49.—CP-264/U true wind computer.

You will then need to begin repair of the primary system that has become inoperative. In the next section, we discuss equipment maintenance and repair.

REVIEW QUESTIONS

- Q51. *What is the purpose of the CP-402/UM calculator?*
- Q52. *What values may be computed by using the CP-165/UM calculator?*
- Q53. *Which calculator is used to compute vapor pressure and specific humidity?*
- Q54. *Besides true wind direction and speed calculations, what additional information can be obtained from the CP-264/U True Wind Computer?*

EQUIPMENT MAINTENANCE

LEARNING OBJECTIVES: Describe procedures to be followed during equipment outages. Recognize the resources available for equipment maintenance and repair assistance. Identify the basics of the Navy's Maintenance and Material Management (3-M) program.

Equipment outages will occur from time to time. In this section, we briefly discuss what should be done when equipment becomes inoperative, and the technicians that will provide maintenance and repair. We also briefly discuss the Navy's preventive maintenance program.

EQUIPMENT OUTAGES

An equipment outage occurs when a device is not available for use. Equipment outages can be caused by power failure, equipment breakdown, or planned maintenance. All equipment outages should be entered in an equipment outage logbook. Logbooks should be maintained for each major equipment system, such as ASOS, SMOOS, AN/GMQ-32, AN/GMQ-13, and the AN/UMQ-5. These logbooks should contain, at the minimum, the date and time the outage began and ended, the reason for the outage (if known), and the name of the person making the entry. Logbooks serve as an important tool for maintenance personnel. Notify your supervisor or section leader of all equipment outages. Your supervisor may then ask you to contact maintenance personnel.

MAINTENANCE RESOURCES

Repair of meteorological or oceanographic equipment can be accomplished through a variety of sources, depending on the severity of the problem. Meteorological and oceanographic equipment is usually maintained and repaired by electronics technicians that have completed Meteorological Equipment Maintenance (METEM) training. These technicians are stationed at most sea and shore commands with weather support facilities. Equipment problems beyond the capability of local technicians may be referred to civilian Field Technical Representatives (FTRs) based at major fleet concentration centers, such as Norfolk, Virginia, and San Diego, California. The contractor for a specific piece of equipment may also provide technical assistance.

3-M SYSTEM

The 3-M System provides support for all shipboard equipment, including all meteorological and oceanographic equipment. Equipment used ashore that is identical to shipboard installed equipment with Ships' 3-M Planned Maintenance System (PMS) support will be maintained using existing PMS coverage. The 3-M System includes both the PMS and the Maintenance Data System (MDS).

The PMS uses maintenance requirements cards (MRCs) to provide detailed step-by-step instructions for preventive maintenance on a particular equipment system. The main purpose of the Planned Maintenance System is to ensure that routine maintenance is completed as required and that maximum equipment operational readiness is achieved. This will help prevent major equipment breakdowns. When

breakdowns do occur, shipboard personnel are called first to repair the equipment. All repair actions are documented in the 3-M System with formatted reports. Further information on the shipboard 3-M System is provided in OPNAVINST 4790.4, *Ships' Maintenance and Material Management (3-M) Manual*. NAVMETOCCOMINST 4790.2, *Maintenance and Material Management (3M) Systems Policies and Procedures*, provides detailed guidance on PMS and MDS unique to Naval Meteorology and Oceanography Command (NAVMETOCCOM) activities.

REVIEW QUESTIONS

- Q55. *What information should be entered in an equipment outage logbook?*
- Q56. *Which personnel are primarily responsible for routine maintenance and repair of meteorological and oceanographic equipment?*
- Q57. *What is the main purpose of the 3-M system?*

SUMMARY

In this chapter we have discussed the equipment commonly used to conduct a surface aviation weather observation. Although your unit may not have some of this equipment, you should be able to identify the purpose of each piece of equipment. More importantly, you should be able to identify the reference manuals that provide the necessary instructions on the operation and maintenance of each equipment system. We strongly recommend that you review the operator manuals for each equipment system or major component in use at your command.

ANSWERS TO REVIEW QUESTIONS

- A1. *Every minute.*
- A2. *Infrared beam.*
- A3. *Tactical Environmental Support System (TESS).*
- A4. *12,000 feet.*
- A5. *Via satellite.*
- A6. *The display group and the sensor group.*
- A7. *Time, air temperature, dew-point temperature, maximum and minimum temperature, wind direction and speed, pressure, and rainfall.*
- A8. *Through a data transmission line.*
- A9. *To store backup observing equipment.*
- A10. *Keep the shelter free of dirt and oil the door hinges.*
- A11. *Alcohol and mercury.*
- A12. *NAVMETOCCOMINST 3141.2 and NAVMETOCCOMINST 3144.1.*
- A13. *To the nearest 1/10 of a degree at the top of the meniscus.*
- A14. *Weekly.*
- A15. *NAVSEAINST 5100.3.*
- A16. *Electric, sling, and rotor.*
- A17. *Point the air intake into the wind and turn the fan motor on. After 60 seconds, read the wet-bulb temperature at 10-second intervals until the temperature reads the same for two consecutive readings.*
- A18. *Changing the wet-bulb wick, keeping the instrument clean and dry, changing the batteries and light bulbs, and lubricating the motor.*
- A19. *Twice every year aboard ship and every year at shore stations.*
- A20. *Tap the face of the instrument and align the indicator arm over the reflection in the mirror. Read the scale to the nearest 0.005 inch or 0.1 hPa and apply any corrections.*
- A21. *If the altimeter settings computed from the DASI are off by more than 0.02 inches from the altimeter settings computed from the aneroid barometer.*

- A22. *An adjustable, grease-filled, dampening cylinder cancels out shipboard vibrations and the pitch and roll of the ship.*
- A23. *Every 4 days at 1200 UTC, and on the first day of the month. Time should be set to UTC.*
- A24. *Seven to eight pulls.*
- A25. *Time adjustments are required when the time is in error by 15 minutes or more, and pressure adjustments are required when the pressure is off by 1.5 hPa or more.*
- A26. *The AN/UMQ-5 wind-measuring set, the Type B-3 wind-measuring system, and the AN/PMQ-3 hand-held anemometer.*
- A27. *At 0000 UTC on the first day of each month and at intermediate times to prevent loss of data.*
- A28. *At the beginning and ending of each chart roll, near the time of each synoptic hour, when notified of an aircraft mishap, for each disruption in the trace, and at the first observation of the day when the station does not operate 24 hours a day.*
- A29. *Relative wind.*
- A30. *Observe the sea height and direction.*
- A31. *The true wind will be less than the apparent wind.*
- A32. *Obtain the ship's course and speed, and then proceed to an unobstructed area of the ship near the windward side. Align the sights with the true-wind reference or the bow of the ship parallel to the centerline.*
- A33. *Only when the wind speed is lower than 15 knots.*
- A34. *1 inch.*
- A35. *The ML-217 rain gauge.*
- A36. *It measures the transmissivity of light through air to determine visibility.*
- A37. *The term "sector visibility" with respect to the AN/GMQ-32 indicates how far an unlighted object can be seen during the day. Runway visual range is how far runway lights can be seen by a pilot.*
- A38. *NAVMETOC COMINST 3141.2.*
- A39. *Transmissivity values are presented on the AN/GMQ-32 in terms of percentages and converted to reportable values (i.e., statute miles) using tables in NAVMETOC COMINST 3141.2.*

- A40. *Replacing the recorder paper, rewinding the recorder, adjusting the recorder zero adjustment, and refilling/cleaning the inkwell and pens.*
- A41. *Rotating beam projector, cloud height detector, and the ceiling height recorder.*
- A42. *Cloud height is determined by the angle of the projected light beam reflected from the base of the clouds directly overhead the receiver.*
- A43. *A correction factor.*
- A44. *When applying the correction factor would yield an elevation angle less than 45°, the correction is ignored and the angle is read as is.*
- A45. *Clinometer.*
- A46. *NAVMETOCCOMINST 3144.1.*
- A47. *After sighting the light spot at the cloud base, determine cloud height by multiplying the baseline distance by the tangent of the elevation angle.*
- A48. *When clouds are thin, or on hazy days.*
- A49. *High winds may carry lighter 10-gram balloons out of sight horizontally before they reach the cloud layer.*
- A50. *Cloud height is determined by the elapsed time, in minutes and seconds, that the balloon takes to enter into the cloud base. The standard ascension rate of the balloon used is compared with height values listed in NAVMETOCCOMINST 3141.2 or NAVMETOCCOMINST 3144.1.*
- A51. *To compute sea-level pressure, altimeter setting, and pressure altitude from station pressure.*
- A52. *Dew-point temperature, relative humidity, and conversion values for the Fahrenheit and Celsius temperature scales.*
- A53. *The CP-718/UM Density Altitude Computer.*
- A54. *It may also be used to compute the ship's course and speed necessary for optimum relative wind direction and speed when conducting flight operations.*
- A55. *The date and time the outage began or ended, the reason for the outage (if known), and the name of the person making the entry.*
- A56. *METEM-qualified technicians.*
- A57. *To ensure that routine maintenance is completed as required and that maximum equipment operational readiness is achieved.*